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Technical Note to Discharge Condition 6 (27354/APP/2021/1291)

Project: 40 Station Approach, Ruislip
Project No: P22-1031
Date: 19th October 2023
Issue: 2

Introduction

This technical note has been prepared by Simpson TWS, on behalf of Chartsfield Ltd. to discharge Planning Condition 6 (Application no. 27354/APP/2021/1291) relating to Sustainable Drainage for the proposed erection of a three storey building comprising a dental surgery and 6 residential units with associated cycle and car parking spaces.

Condition 6

"No above ground development approved by this permission shall be commenced until a scheme for the provision of sustainable water management has been submitted to and approved in writing by the Local Planning Authority. The scheme shall clearly demonstrate that sustainable drainage systems (SUDS) have been incorporated into the designs of the development in accordance with the hierarchy set out in accordance with Policy SI 13 of the London Plan (2021) and will:

- *i. Provide information about the design storm period and intensity, the method employed to delay and control the surface water discharged from the site and the measures taken to prevent pollution of the receiving groundwater and/or surface waters;*
- *ii. Include a timetable for its implementation; and*
- *iii. Provide a management and maintenance plan for the lifetime of the development which shall include arrangements for adoption by any public authority or statutory undertaker and any other arrangements to secure the operation of the scheme throughout its lifetime.*

The scheme shall also demonstrate the use of methods to minimise the use of potable water through water collection, reuse and recycling and will;

- *iv. Provide details of water collection facilities to capture excess rainwater;*
- *v. Provide details of how rain and grey water will be recycled and reused in the development.*

Thereafter the development shall be implemented and retained/ maintained in accordance with these details for as long as the development remains in existence.

REASON
To ensure that development does not increase the risk of flooding in accordance with Policy DMEI 10 of the Hillingdon Local Plan Part 2 (2020) and Policy S1 13 of the London Plan (2021)."

This note should be read in conjunction with the following appended documents:

- Sustainable Drainage Strategy and Report by RTC (RTCL-40SA-001c, March 2021)
- Engineering Layout drawing (P22-1031:101 Rev T1) by Simpson TWS (Sept 2023)
- Drainage Details drawing (P22-1031:103 Rev T1) by Simpson TWS (Sept 2023)
- MicroDrainage Source Control Calculations by Simpson TWS (Sept 2023)
- Implementation, Management & Maintenance Plan by Simpson TWS (Sept 2023)

Planning SuDS Strategy

Engineering Consultants RTC prepared a Sustainable Drainage Strategy and Report (Ref . RTCL-40SA-001c) for this development with the latest version of the report submitted to Hillingdon Borough Council in March 2021 as part of the planning application (Ref. 27354/APP/2021/1291). *Section 7.5* of the appended RTC report details the proposed surface water strategy submitted for planning and states the following:

"Sustainable urban drainage systems have been considered for this development unless there are practical reasons for not doing so. Infiltration techniques are not suitable because the B.G.S records for the site indicate that the strata is likely to be impermeable. Moreover, the infiltration SuDS Suitability Map shown in Appendix F shows the site within a 'Unproductive Aquifer Type'. As there are no watercourses in the vicinity of the site, the next viable technique is 'Discharge rainwater to a surface water drain'.

"A site-specific drainage hierarchy checklist considered for the drainage design for this development is detailed in Table 7.6" of the appended report.

Final SuDS Strategy

The final surface water drainage scheme proposes that a traditional network of separate foul and surface water below ground pipework will serve the development. Foul water will be discharged to Thames Water's foul sewer network via the site's existing foul outfall in the north of the site. Surface water will discharge to Thames Water's surface water sewer network in the south of the site via a new saddle connection.

Surface water drainage strategies aim to arrange SuDS to form a surface water management train that collectively captures, conveys, and stores surface water runoff from development whist also delivering interception and pollution risk management. A surface water drainage approach for the development based on these principles and the SuDS identified to be suitable for the development is outlined below and shown in the Engineering Layout which has been appended to this note. *Table 1* below shows which sustainable drainage features will be used on site.

Table 1: SUDS Suitability

SuDS Element	Suitability
Rainwater Harvesting	×
Infiltration Systems	×
Blue / Green Roofs	×
Filter Strips	×
Filter Drains	×
Bioretention Systems	×
Permeable Pavements	✓
Swales	×
Basins / Ponds	×
Attenuation Tanks	✓
Proprietary Treatment Systems	×

From the assessment completed in *Table 1* the surface water drainage scheme will comprise:

- Roof water from the proposed building will be collected by rainwater down pipes, with runoff from external areas collected by ACO channel drains. Runoff from these areas would discharge into the porous sub-base beneath permeable paving areas to the south via a Polypipe permavoid diffuser unit to allow runoff to enter the attenuation tank whilst also providing filtration treatment.

- Permeable paving would be used for the interception and treatment of surface water runoff from the parking area to the south. Permeable paving allows surface water runoff to filter through a block paved surface into a filter zone of sub-base beneath the bedding layer that would comprise of 30% voids, and temporarily store the surface water.

- Excess flows will be stored and attenuated within a geocellular attenuation tank located beneath the parking with porous sub-base extended to the top of the tank to allow runoff to filter into the tank.

- A flow control chamber is proposed downstream of the attenuation tank and upstream of the outfall to the surface water sewer network. The flow control chamber would be fitted with a hydro-brake which limits flows to a maximum allowable discharge rate of 0.4 l/s, as specified within RTC's drainage strategy report submitted for planning.

Microdrainage Source Control calculations have been appended to this note and show that the peak runoff rates would comply with the planning scheme, with peak runoff rates shown to be less than or equal to a rate of 0.4 l/s. The appended design results also demonstrate that flooding would not occur for any of the analysed rainfall events up to and including the 100 year return period with a 40% allowance for all climate change.

Implementation, Management & Maintenance

Condition 6 requires a timetable for the implementation of the proposed Sustainable Drainage System, and a management and annual maintenance plan for the lifetime of the development. An Implementation, Management & Maintenance Plan has been prepared for the development and is appended to this note to address this element of the condition.

Water Collection, Reuse & Recycling

Condition 6 also requires details of water collection, reuse & recycling facilities for the development. However, following discussions with the M&E Engineer involved with the scheme it has been determined that due to the proposed building footprint occupying the majority of the site, below ground attenuation tank proposed beneath the car park and owing to the structural complexities of the scheme there would be no residual room for an above or below ground storage tank associated with rain/grey water harvesting.

In addition, it is considered that rainwater harvesting is unlikely to contribute to a reduction in surface water runoff volumes as the nature of the development uses proposed would have limited requirement for recycled rainwater. Therefore, rain/grey water harvesting has not been proposed for the scheme.

Conclusion

It has been established that the final drainage strategy aligns closely with the scheme proposed during planning. Furthermore, details of how the proposed drainage system will be implemented, managed and maintained are provided in an appended report.

On this basis, it is considered that sufficient information has been provided to demonstrate that the drainage techniques proposed at planning will be implemented and maintained during construction and future operation for the lifetime of the development.

RTC

Construction Consultancy

Collaboration Completion

40 Station Approach

Ruislip

HA4 6RZ

Sustainable Drainage Strategy and Report

RTC

Site Reference

40 Station Approach

Ruislip

HA4 6RZ

Report No.

RTCL-40SA-001c

Client

Albion Housing Limited

Date

23/03/2021

Revision	Compiled By	Checked By	Amendment	Issue Date
A	R. Thorpe BSc (hons) MSc MCIOB	B. Beresford MEng (Hons) MSc CEng MICE	-	06.07.2020
B	R. Thorpe BSc (hons) MSc MCIOB	B. Beresford MEng (Hons) MSc CEng MICE	Update following BB Review	21.07.2020
C	R. Thorpe BSc (hons) MSc MCIOB	B. Beresford MEng (Hons) MSc CEng MICE	Update following Design Team Review	10.12.2020
D	R. Thorpe BSc (hons) MSc MCIOB	B. Beresford MEng (Hons) MSc CEng MICE	Update following change in unit mix	23.03.2021

Executive Summary

This Flood Risk Assessment (FRA) has been prepared in accordance with the requirements set out in the National Planning Policy Framework (NPPF) and the associated Planning Practice Guidance. It has been produced for the planning application for the proposed development of 40 Station Approach into a dental surgery (Use Class E) and 6 residential units (Use Class C3) (approximate grid reference: TQ 10963 85231).

This report demonstrates that the proposed development is not at significant flood risk.

The site is indicated to lie within Flood Zone 1 which is deemed Low Probability.

The site is not within a Critical Drainage Area within London Borough of Hillingdon and therefore at low risk of surface and sewer flooding.

Based on this assessment, it is concluded that in accordance with the Flood risk vulnerability and flood zone compatibility table in Section 5.6 from the Planning Practice Guidance document, the proposed development is appropriate on flooding grounds.

2.0 Introduction

This Flood Risk Assessment (FRA) has been prepared in accordance with the requirements set out in the National Planning Policy Framework (NPPF) and the associated Planning Practice Guidance. It has been produced for the planning application for the proposed development of 40 Station Approach into a dental surgery (Use Class E) and 6 residential units (Use Class C3)(approximate grid reference: TQ 10963 85231). Key site details are presented in table 2.1.

Item	Response
Site Location	The site is in Ruislip, bound by Station Approach to the north, Northolt Ave to the west, by residential buildings to the east and by a service road to the south. The site is located less than 400m away from RAF Northolt Airport. The approximate grid reference E: 510963, N: 185231 (Nat Grid TQ 10963 85231)
Size and Current Land Usage	The brownfield site is approximately 0.04ha in plan, rectangular in shape, and it is currently occupied by one double storey building and associated car park area.
Flood Zone	The development site falls entirely within Flood Zone 1, which is classified as low probability of flooding.
Fluvial Flood Risk	Low – Refer to Section 6.1
Overland Flood Risk	Low – Refer to Section 6.2
Groundwater Flood Risk	Low – Refer to Section 6.3
Sewerage Flood Risk	Low – Refer to Section 6.4
Artificial Flood Risk	Low – Refer to Section 6.5
Critical Drainage Area	This development site falls entirely outside of the critical drainage area. – Refer to Section 6.6
Proposed Development	The development includes a commercial unit, 6 units with a mix of purpose-built one, two and three bedroom flats together with associated facilities and allocated car parking

2.1 Commission

Albion Housing Limited has commissioned R. Thorpe Consultancy Ltd, to prepare a Sustainable Drainage Strategy and Report to support a Planning Application of 6 residential units and 1 commercial unit on land at Station Approach, HA4 6RZ.

2.2 Guidance

This flood risk assessment has been compiled in accordance with the recommendations of the National Planning Policy Framework and the Technical Guidance to the National Planning Policy Framework.

2.3 Aims and Objectives

The purpose of this flood risk assessment is to assess the potential flood risks by and to a potential development. It will identify the flood risk zone as well as potential sources of flood risk and will be used to support the proposed planning application.

3.0 Site Details

3.1 Location

The site is in Ruislip, 400m east of RAF Northolt Airport. It is bound by Station Approach to the north, Northolt Ave to the west, by residential buildings to the east and by a service road to the south.

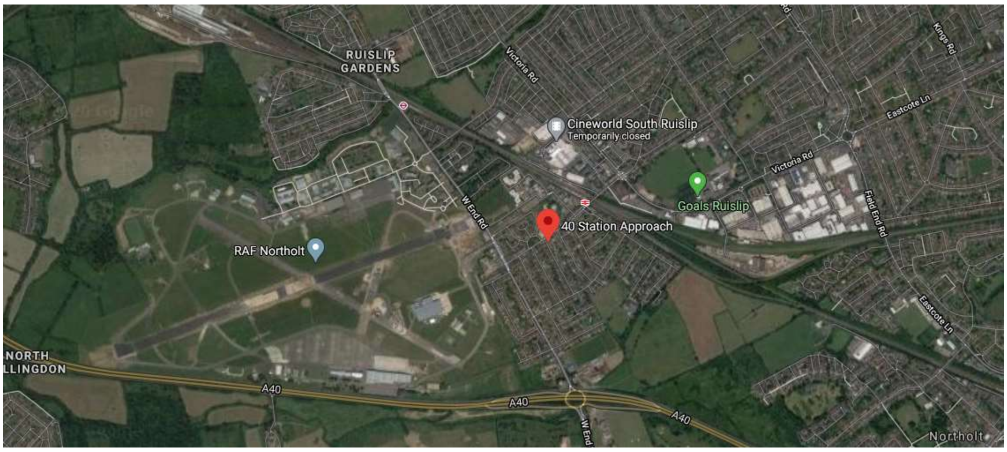

Figure 3.1.1 – Site Location

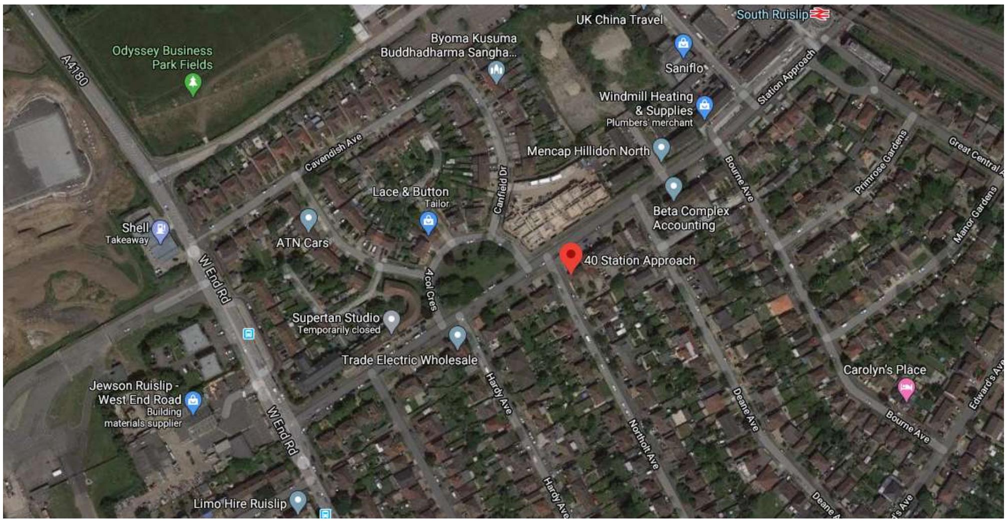

Figure 3.1.2 – Site Context

3.2 Grid Reference

The Ordnance Survey National grid reference for the centre of the site is E: 510963, N: 185231 (Nat Grid TQ 10963 85231).

3.3 Topography and Site Description

The brownfield site, rectangular in shape, is approximately 0.04ha in plan and it is currently occupied by one two storey building and associated car park area and hardstanding to the front and rear of the Site. There are two existing vehicular accesses via Station Approach and Northolt Ave.

The Site is flat and located at approximately 37mAOD.

3.4 Ground Conditions

At the time of writing, intrusive site investigation works were not undertaken on site. However, based on the British Geological Survey map viewer, the development is over the London Clay Formation, close to the Lambed Group. According to previous boreholes undertaken in the vicinity, the clay stratum is over 20m deep. See Appendix G for Geological Information.

3.5 Ground Water

Trial pits as part of the site investigation must be undertaken post planning to a maximum depth of 3m clarify if the water table level sits within this level. Records of boreholes in the vicinity, provided by the B.G.S did not encountered water within 10mbgl due to the clay nature of the strata.

3.6 Existing Site Drainage

The Thames Water wastewater plans show separated foul and surface water sewers within Northolt Ave., immediately to the west of the site and foul water sewer within Station Approach immediately to the north of the site. The foul water sewer and surface water sewer are both Ø225mm. The depth of the foul system is 2.0m and the depth of the surface water sewer is 1.5m. Within the confines of the development site there are existing foul and surface water drainage systems connecting into the Northolt Ave. sewers. Refer to Appendix B for the Thames Water Sewer Records.

3.7 Existing Watercourses

The nearest river watercourse to the is the Yeading Brook, 850m to the north and the 700m to the south. The closest main river is River Pinn, 3.3Km to the north.

4.0 Proposed Development

The development proposals consist of 6 residential units with a mix of one, two and three bedroom flats and a commercial unit to be occupied by a dental surgery. Additional functional facilities, such as off-road car parking, are also an integral part of this scheme. The proposed planning layout drawings are contained within Appendix A.

5.0 Flood Risk Policy

5.1 Environment Agency Flood Map

The flood map for the development site shown below suggests that the site wholly falls within flood zone 1, which is defined as land assessed as having a less than 1 in 1000 annual probability of river flooding in any one year.

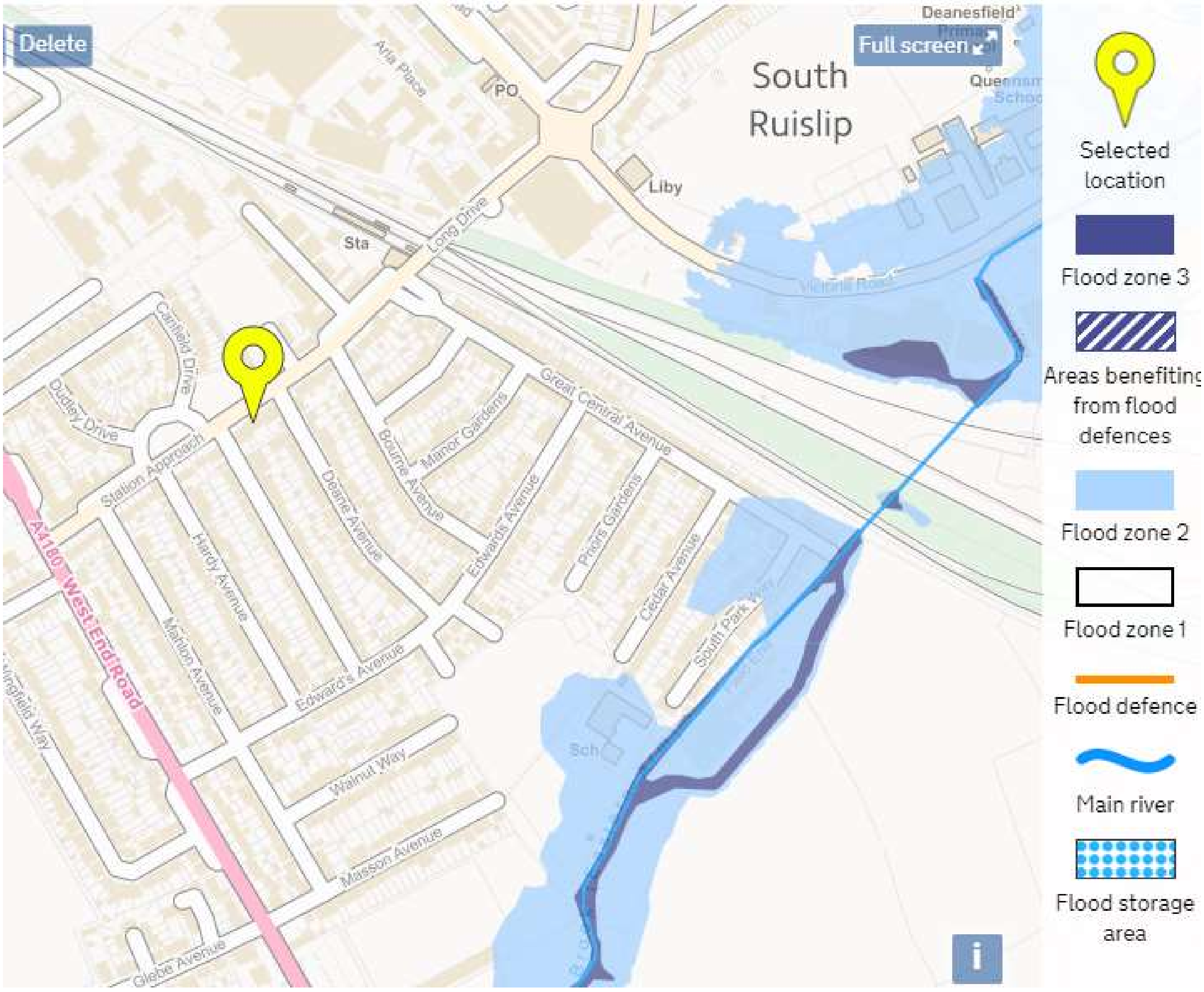

Figure 5.1 – Environmental Agency Flood Zone Map

5.2 The National Planning Policy Framework

The National Planning Policy Framework and the accompanying Planning Practice Guidance gives direction for development with respect to flooding. These documents promote a sequential approach to encourage development away from areas that may be or are susceptible to flooding. In doing so it categorises flood zones in the context of their probability of flooding, as shown in the table within Section 5.3 below.

5.3 Flood Zone Definition

The National Planning Policy Framework Definition of Flood Zones

Flood zone	Fluvial	Tidal	Probability of Flooding
1	<1 in 1000 year	<1 in 1000 year	Low probability
2	Between <1 in 1000 year and 1 in 100 year	Between <1 in 1000 year and 1 in 200 year	Medium probability
3a	> 1 in 100 year	> 1 in 200 year	High probability
3b	Either > 1 in 20 or as agreed between the EA and the LPA	Either > 1 in 20 or as agreed between the EA and the LPA	Functional flood plain

5.4 Flood Zones – Table 1 Technical Guidance to NPPF

(Note: These Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences)

Zone 1 - Low Probability
Definition
This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).
Appropriate uses
All uses of land are appropriate in this zone.
FRA requirements
For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the development on surface water run-off, should be incorporated in a FRA. This need only be brief unless the factors above or other local considerations require particular attention.
Policy aims
In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage techniques.

5.5 Flood Risk Vulnerability Classification – Extract from Table 2 Technical Guide to NPPF

More Vulnerable

- Hospitals
- Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels.
- Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels.
- Non–residential uses for health services, nurseries, and educational establishments.
- Landfill and sites used for waste management facilities for hazardous waste.
- Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan

5.6 Flood Risk Vulnerability & Flood Zone Compatibility Table

Vulnerability classification flood zone	Essential infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less vulnerable
1	√	√	√	√	√
2	√	√	Exception test required	√	√
3a	Exception test required	√	X	Exception test required	√
3b	Exception test required	√	X	X	X

√ Development is appropriate x development is not appropriate

The above table, taken from Technical Guidance to the NPPF (table 3), confirms that residential properties within flood zones 1 is appropriate development. A Class E commercial unit (dental surgery) is also an appropriate use in flood zone 1.

5.7 Other Flooding Mechanisms

In addition to the potential for assessing flooding from fluvial and tidal sources NPPF also requires that consideration is given to other mechanisms for flooding:

- Flooding from land – intense rainfall, often in short duration, that is unable to soak into the ground or enter drainage systems, can run rapidly off land and result in local flooding.
- Flooding from groundwater – occurs when water levels in the ground rise above the surface elevations.
- Flooding from sewers – In urban areas, rainwater is frequently drained into surface water sewers or sewers containing both surface and waste water sewers known as combined sewers. Flooding can result causing surcharging when the sewer is overwhelmed by heavy rainfall.

- Flooding from reservoirs, canals and other artificial sources – Non-natural or artificial sources of flooding can result from sources such as reservoirs, canals lakes etc, where water is held above natural ground levels.

5.8 Local Strategy FRA & Local Policy

A strategic flood risk assessment (SFRA) was undertaken by the London Borough of Hillingdon in May 2011. This document references the historic flood events associated with the city, however no references associated with the development site or local area are mentioned. The Hillingdon Local Plan: Part 1- Strategic Policies sets out the long-term vision and objectives for the Borough, what is going to happen, where, and how this will be achieved. Relevant sections include "Surface and Foul Water Drainage" (Section 8.87 – 8.91):

> *"The mismanagement of surface water flooding can also result in the increased risk of flooding. Sewage and drainage systems struggle to keep pace with the rate of development. The unchecked loss of natural drainage areas through increased hardstanding puts significant pressure on drainage systems, particularly in times of heavy rain. As development progresses and/or urban areas expand these systems become inadequate for the volumes and rates of storm water they receive, resulting in increased flood risk and/or pollution of watercourses. Allied to this are the implications of climate change on rainfall intensities, leading to flashier catchment/ site responses and surcharging of piped systems.*
>
> *The impacts of climate change will add to the pressure on the drainage systems and it is therefore essential that all new development is managed to minimise the problems.*
>
> *The management of surface water drainage for new development comes in the form of Sustainable Urban Drainage Systems (SUDS). These seek to manage storm water as close to its source as possible, mimicking storm water flows arising from the site, prior to the proposed development. Typically this approach involves a move away from piped systems to softer engineering solutions inspired by natural drainage processes.*
>
> *SUDS should be designed to take into account the surface run-off quantity, rates and also water quality ensuring their effective operation up to and including the 1 in 100 year design standard flood including an increase in peak rainfall of up to 30% to account for climate change.*
>
> *SUDS come in a variety of different types, from infiltration techniques through to water harvesting. Wherever possible, a SUDS technique should seek to contribute to each of the three goals identified below with the favoured system contributing significantly to each objective. Where possible SUDS solutions for a site should seek to: Reduce flood risk (to the site and neighbouring areas); Reduce pollution; and Provide landscape and wildlife benefits."*

Further relevant local planning policy sections include:

"Policy EM6: Flood Risk Management

The Council will require new development to be directed away from Flood Zones 2 and 3 in accordance with the principles of the National Planning Policy Framework (NPPF).

The subsequent Hillingdon Local Plan: Part 2 -Site Specific Allocations LDD will be subjected to the Sequential Test in accordance with the NPPF. Sites will only be allocated within Flood Zones 2 or 3 where there are overriding issues that outweigh flood risk. In these instances, policy criteria will be set requiring future applicants of these sites to demonstrate that flood risk can be suitably mitigated.

The Council will require all development across the borough to use sustainable urban drainage systems (SUDS) unless demonstrated that it is not viable. The Council will encourage SUDS to be linked to water efficiency methods. The Council may require developer contributions to guarantee the long term maintenance and performance of SUDS is to an appropriate standard."

6.0 Potential Sources of Flood Risk

6.1 Flooding from Fluvial Sources

The proposed development site lies entirely within flood zone 1, which is classified as land assessed as having a less than 1 in 1000 annual probability of river or sea flooding and is appropriate to all uses of land. For further information refer to the map taken from the Strategic Flood Risk Assessment for the London Borough of Hillingdon found within in Appendix D of this report.

It is, therefore, the consideration of this FRA that the site has a low risk of flooding from fluvial sources.

6.2 Flooding from Overland Flows

The risk of flooding due to overland flood flows within the site is considered negligible by the Environment Agency. Station Approach appears to be in the low risk of flooding. See Appendix D for the full maps provided in the Strategic Flood Risk Assessment for the London Borough of Hillingdon.

Fig 6.2 – Environment Agency Flood Risk from Surface Water map

It is, therefore, the consideration of this FRA that the site has a low risk of flooding from overland flow.

6.3 Flooding from Rising Groundwater

Groundwater flooding is dependent on local variations in topography, geology and soils. The causes of groundwater flooding are generally understood; however, it is difficult to predict the actual location, timing and extent of groundwater flooding without comprehensive datasets. See Appendix E for Groundwater Risk Assessment.

It is, therefore, the consideration of this FRA that the site has a low risk of flooding from rising groundwater levels.

6.4 Flooding from the Local Sewerage Network

The closest public sewers to the development site are located within Northolt Ave. and Station Approach. In the event of these systems surcharging, it is unlikely that flood water will encroach into the site, as the flows will follow the topography of the adjacent roads, which fall away from the site.

It is, therefore, the consideration of this FRA that the site has a low risk of flooding by surcharging of the local sewer network.

6.5 Flooding from Reservoirs, Canals & Other Artificial Sources

There is no risk of flooding associated with these bodies of water, as shown on the map below provided by the Environment Agency.

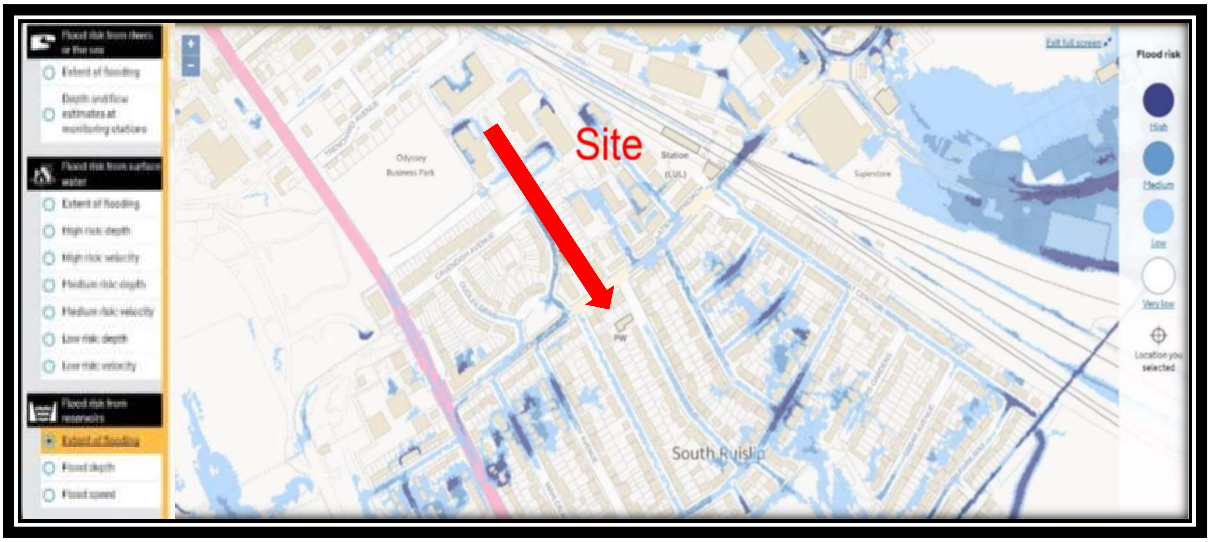

Fig 6.7 – Environment Agency Flood Risk from Reservoirs map

6.6 Critical Drainage Area

This development site falls entirely outside of the critical drainage area, as shown on the map below provided by Hillingdon Council.

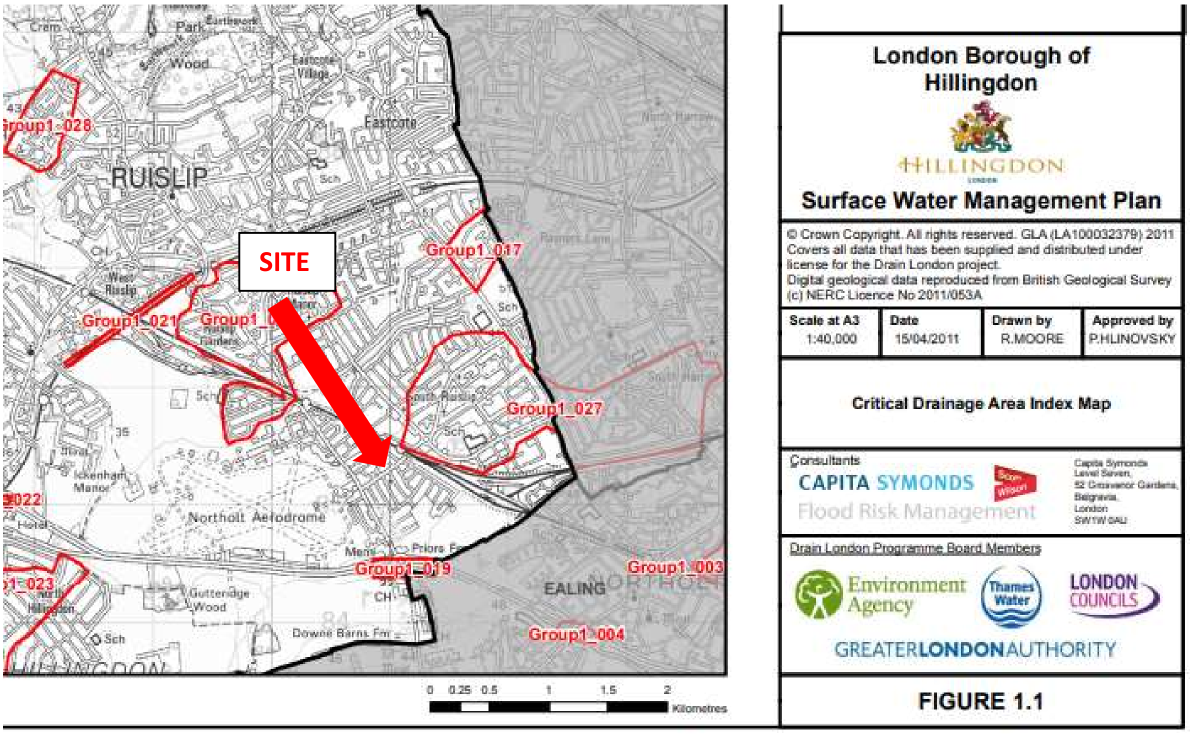

Fig 6.8 – Critical Drainage Area Index Map

It is, therefore, the consideration of this FRA that the site has a low risk of flooding by reservoirs, canals or other artificial sources.

7.0 Effect of Development on Wider Catchment

7.1 Effect of The Development Generally

Development by its nature usually has the potential to increase the impermeable area with a resultant increased risk of causing rapid surface water runoff to watercourses and sewers, thereby causing surcharging and potential flooding. There is also the potential for pollutants to be mobilised and consequently flushed into the receiving surface water system. Increases in both the peak runoff rate (usually measured in litres per second l/s) and runoff volume (cubic metres m3) can result.

7.2 Surface Water Drainage & Sustainable Drainage Systems

Sustainable Drainage techniques (SuDS) covers a range of approaches to manage surface water runoff so that:

'Surface water arising from a developed site should, as far as is practicable, be managed in a sustainable manner to mimic the surface water flows arising from the site prior to the proposed development, while reducing the flood risk to the site itself and elsewhere, taking climate change into account. This should be demonstrated as part of the flood risk assessment'.

7.3 Peak Storm Design Criteria

The proposed sustainable drainage techniques for the development should accommodate the peak rainfall event for a 1 in 100 year storm event with an additional allowance for climate change. Table 5 of NPPG recommends for developments that have a life expectancy beyond 2085 that an additional factor of 40% is applied to the peak volume of runoff.

7.4 Existing Surface Water Runoff Rates

The development site is considered brownfield comprising of an area of approximately 0.04ha. The existing runoff rates calculated for site are highlighted below:

Return Period	Brownfield Runoff Rate l/s	Greenfield Runoff Rate l/s
1 in 1 year	3.5	0.4
Qbar	4.5	0.4
1 in 30 year	7.2	0.7
1 in 100 year	8.7	0.9

Table 7.4 Existing Runoff rates

7.5 Sustainable Drainage Hierarchy

A hierarchical approach has been undertaken in consideration of the application of SuDS in relation to the development. This is in order to meet the design philosophy of ensuring that surface water run-off is managed as close to its source as possible and the existing situation is replicated as closely as possible.

The following drainage hierarchy has been undertaken with reference to the procedures set out in the SuDS Manual (CIRIA C753, 2015) to assess the viability of the application of SuDS techniques to this scheme:

1. Store rainwater for later use
2. Use infiltration techniques, such as porous surfaces in permeable strata areas
3. Attenuate rainwater in ponds or open water features for gradual release to a watercourse.
4. Attenuate rainwater by storing in tanks or sealed water features for gradual release to a watercourse,
5. Discharge rainwater direct to a watercourse
6. Discharge rainwater to a surface water drain
7. Discharge rainwater to the combined sewer.

The sustainable drainage hierarchy shown above is intended to ensure that all practical and reasonable measures are taken to manage surface water higher up the hierarchy (1 being the highest) and that the amount of surface water managed at the bottom of the hierarchy is minimised.

Sustainable urban drainage systems have been considered for this development unless there are practical reasons for not doing so. Infiltration techniques are not suitable because the B.G.S. records for the site indicate that the strata is likely to be impermeable. Moreover, the infiltration SUDS Suitability Map shown in Appendix F shows the site within a "Unproductive Aquifer Type". As there are no watercourses in the vicinity of the site, the next viable technique is "Discharge rainwater to a surface water drain".

The site-specific drainage hierarchy checklist considered for the drainage design for this development is detailed in table 7.6.

SUDS OPTIONS	Comments	Potential for flow rat e control	Volume Reduction	Maintenance requirement	Space Requirement	Cost	Included in final detailed design
Rainwater harvesting	Rainwater from roof runoff collected for re-use. Cost-benefit considerations	L	M	H	L	H	Pos
Water butts	Rainwater collection from roof runoff. Included in final design	L	L	L	L	L	Pos

Living roofs	Vegetated roofs that reduce runoff volume and rate	M	L	M	L	H	Pos
Bio-retention	Shallow vegetated areas to retain and treat runoff.	L	L	M	M	L	Pos
Constructed wetlands	Waterlogged areas that can support aquatic vegetation. Replicates existing conditions and provides ecological benefit.	M	L	H	H/M	M	N
Swales	Shallow grassed drainage channels. Replicates existing conditions	H	M	L	M/H	L	N
Soakaways	Subsurface structures that dispose of water via infiltration.	H	H	L	L	M	N
Permeable pavements	Surface that infiltrate through surface. Retains pollutants.	H	H	M	L	M	Pos
Tanked storage systems	Oversized pipes, Cellular storage or Tanked Permeable Paving.	H	L	L	M	M/H	Pos
Infiltration basins	Depressions in the ground to store and release water through infiltration	H	H	M/H	H	M/L	N
Detention basins	Temporary retention of runoff with controlled discharge	H	L	M	H	M/L	N

Table 7.6 Drainage design hierarchy (SuDS techniques considered for use in this scheme)

It should be noted that where the SuDS techniques are noted as feasible or possible it does not necessarily follow that they will all be used.

7.6 SUDS Techniques Employed

It is proposed to collect water from roof runoff through a piped network that will discharge it into the Thames Water surface water sewer, at a limited flow rate of 0.4l/s, to match that of the Qbar greenfield run off rate for the site. It is recommended that prior to commencement on site, the existing drainage laterals serving the site are CCTV surveyed to ensure that they are in a suitable condition for re-use and any associated remedial works required are clearly noted on the contract drawings. Surface Water from the site is to be dealt with via a series of SuDS measures, which are detailed below:

Rain Gardens/Planters

There are roofs proposed within the scheme. It is the intention to divert clean surface water from the roof areas above, into these for natural irrigation, with overflows back out into the piped system. The use of lower rain gardens on the ground floor are also to be implemented. As the extensive use of these measures are being proposed at ground floor level, this report suggests that the use of green/brown roofs is not implemented within the design. By omitting the use of green/brown roofing ensures that even during smaller storm events, the rain gardens will receive an element of surface water for irrigation purposes. The use of rain gardens therefore provides a treatment train to surface water at source, removing the need for green roofs and provides accessible SuD's measures that can easily be managed and maintained by the end users without specialist equipment.

The proposed revised surface water flow rates off site detailed below in table 7.6.

Return Period	Existing Runoff Rate l/s	Proposed Runoff Rate l/s	Reduction l/s
1 in 1 year	3.5	0.4	3.1
Qbar	4.5	0.4	4.1
1 in 30 year	7.2	0.4	6.8
1 in 100 year	8.7	0.4	8.3

Table 7.6 Brownfield and proposed runoff rates

7.7 Flood Risk Maintenance

Unlike conventional drainage systems, some SuDS features are visible, and their function should be easily understood by those responsible for maintenance. When problems occur, they are generally obvious and can be remedied simply, using standard landscaping practice. During the first year of operation of all types of SuDS, inspections should usually be carried out at least monthly (and after significant storm events) to ensure that the system is functioning as designed and that no damage is evident.

8.0 Foul Water Drainage Design

The development proposals will seek to discharge foul water from the development site into the Thames Water foul drainage system running within proximity of the site. This will be subject to a Water Industry Act 1991 Section 106 consent from Local Water Authority, Thames Water. Flows into these systems will be via a gravity fed connection.

9.0 Recommendations and Conclusion

The development proposals together with the site layout have been assessed in relation to the provision of SuDS drainage associated with the works. The report has assessed the feasibility of implementing the SuDS hierarchal approach and has confirmed that this development is likely to be able to install suitable drainage measures into the design proposals. Therefore, in line with the recommendations of the National Planning Policy Framework, the development site lies within land classified as flood zone 1, which is considered at a low risk of flooding, and therefore appropriate for a development of this nature. Having assessed the other forms of flood risk to and from the development site, this report finds that the site is not considered at high risk from any other sources of flooding.

10.0 References & Bibliography

- The National Planning Policy Framework March 2012
- Planning Practice Guidance.
- Code for Sustainable Homes - Department of Communities and Local Government. Revised February 2008.
- Environment Agency - Rainfall-Runoff Management for Developments.
- Environment Agency indicative flood maps http://maps.environment- agency gov.uk.
- Environment Agency indicative groundwater source protection zone maps http://maps.environment-agency gov.uk.
- Environment Agency indicative Aquifer designation maps http://maps.environment-agency gov.uk.
- CIRIA 2007, The Sustainable Drainage Systems (SUDS) Manual C753.
- Sewers for adoption 7th Edition.
- Strategic Flood Risk Assessment – London Borough of Hillingdon, 2011
- Hillingdon Surface Water Management Plan maps https://archive.hillingdon.gov.uk/ article /26460/Surface-Water-Management-Plan-maps
- Hillingdon Critical Drainage Area Index Map https://archive.hillingdon.gov.uk/media /27860/Fig1.1---Critical-Drainage-Area-Index-Map-North/pdf/Fig1.1_ Critical_Drainage_Area_Index_Map_North.pdf

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Appendix A – Architectural Proposals

Appendix B – Thames Water Sewer Records

Appendix C – Environmental Agency Flood Map

Appendix D – Surface Water Flooding

Appendix E – Ground Water Flooding

Appendix F – Infiltration Suitability

Appendix G – Geology

Working with

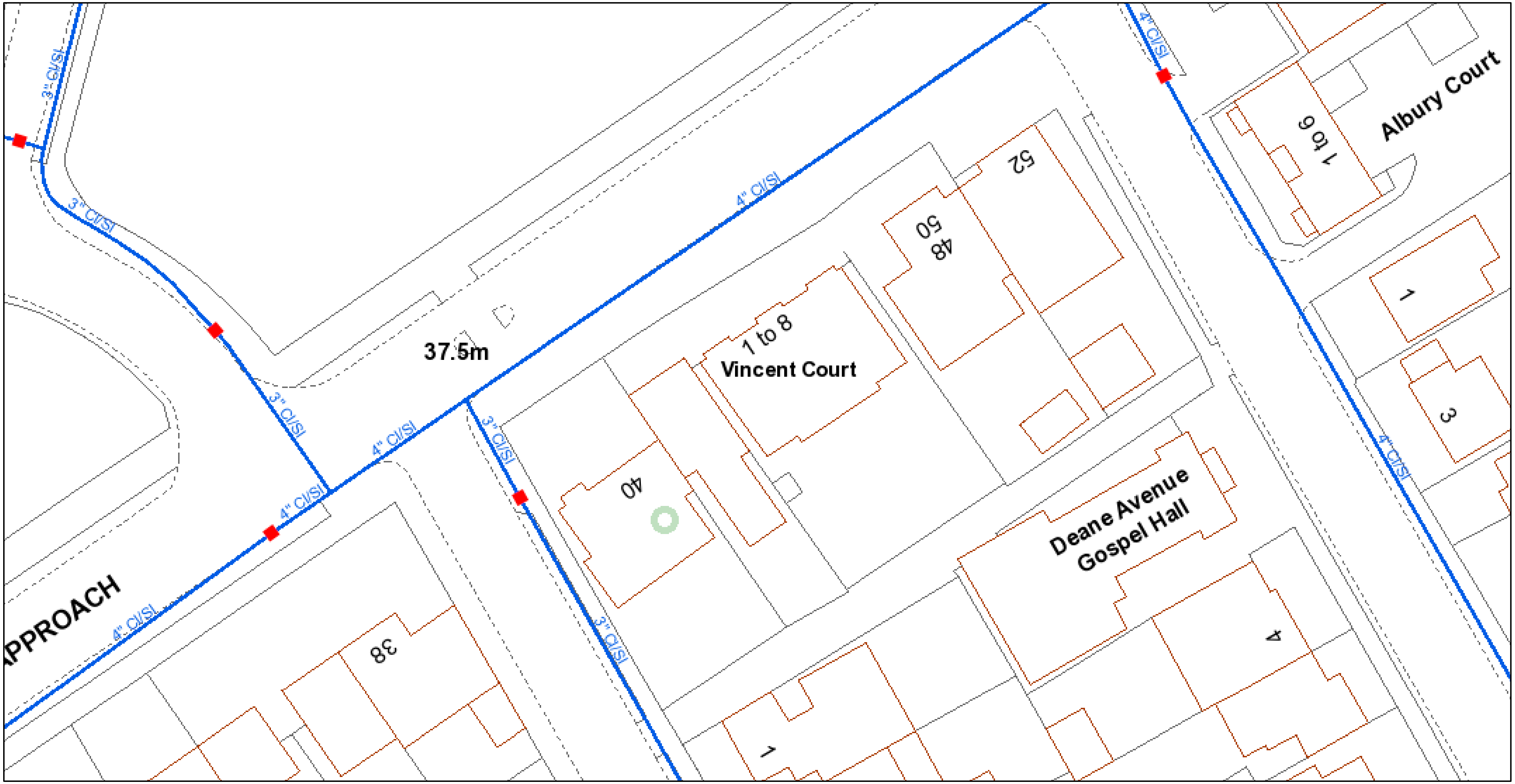
www.affinitywater.co.uk

www.thameswater.co.uk

Affinity Water

Title

Created on - 29/06/2020



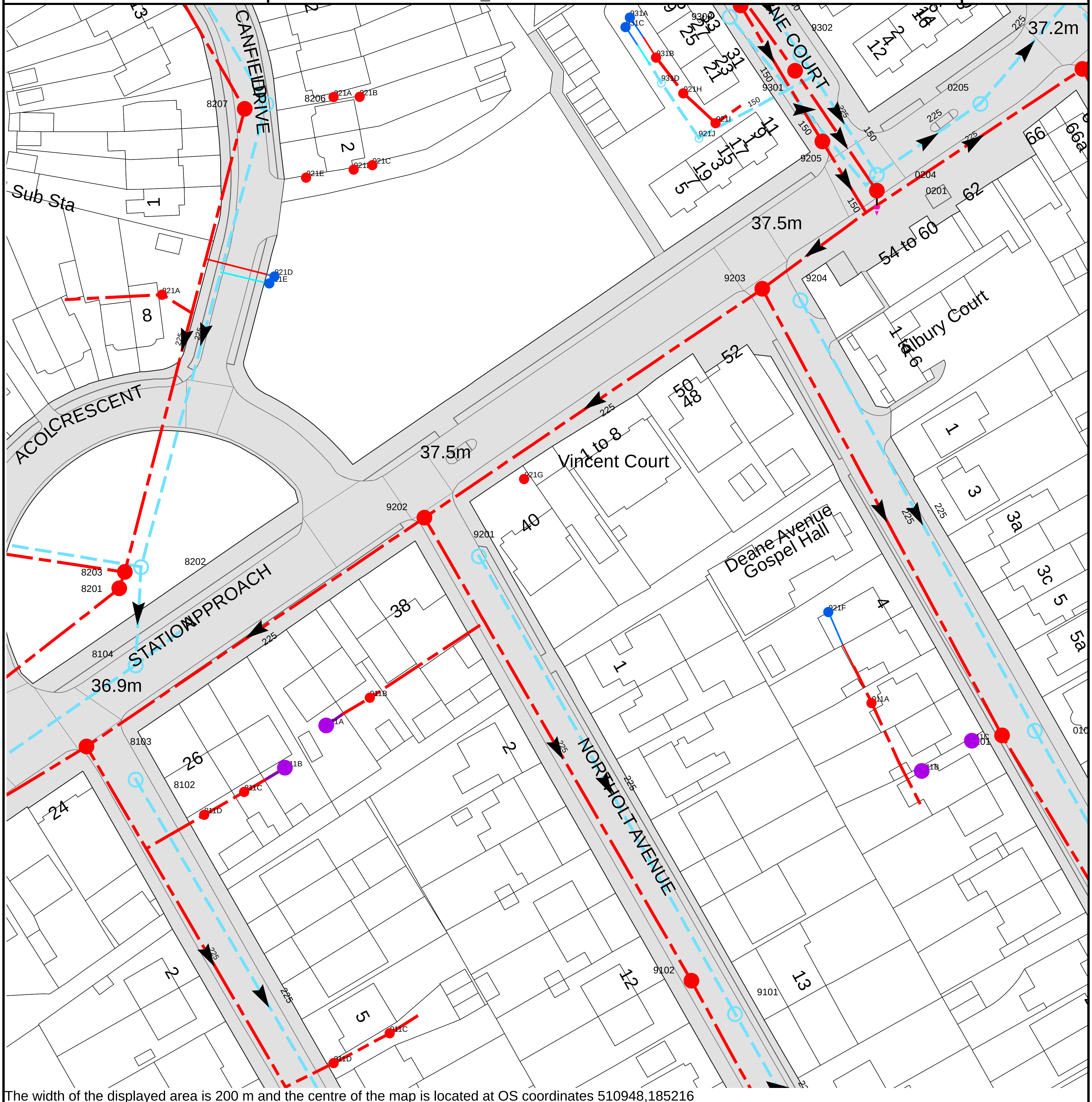
Plans are continuously being updated, so out of date plans should be destroyed and not relied upon. The position of apparatus shown on this plan is provided for guidance only and should not be relied upon as being precise. Therefore the Company accepts no responsibility in the event of inaccuracy. Service pipes are not necessarily shown on this plan. Cover is normally 915mm for mains and 750mm for communication pipes but this may vary.
The actual position of apparatus must be determined on site by making hand dug trial holes. The Company requires a minimum of two working days notice of the intention to excavate trial holes.
Except where prior written permission has been obtained, it is an offence under Section 174 of the Water Industry Act 1991 to operate or interfere with any valves, hydrants or other apparatus vested in Affinity Water.

N

1:506

- Distribution Main
- Asbestos Distribution Main
- Abandoned Main
- Asbestos Abandoned Main
- Adit / Tunnel
- Cable
- Searched Location
- Hydrant
- Fitting
- Easement
- Company Boundary

Asset Location Search Sewer Map - ALS/ALS Standard/2020_4205880



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 510948,185216

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

Manhole Reference	Manhole Cover Level	Manhole Invert Level
921J	n/a	n/a
921I	n/a	n/a
9308	37.51	36.33
9305	37.52	36.18
9301	37.38	36.02
9302	37.39	35.69
9205	37.47	36
0204	37.44	35.55
0205	37.33	35.38
0303	37.19	35.18
8207	38.27	36.14
8206	38.44	36.51
921E	n/a	n/a
921A	n/a	n/a
921D	n/a	n/a
921B	n/a	n/a
921C	n/a	n/a
931C	n/a	n/a
931A	n/a	n/a
931B	n/a	n/a
931D	n/a	n/a
921H	n/a	n/a
811C	n/a	n/a
8102	36.67	34.81
811B	n/a	n/a
8103	36.86	34.8
911A	n/a	n/a
911B	n/a	n/a
8104	37.14	35.41
921F	n/a	n/a
8201	37.29	35.11
8203	37.34	35.12
8202	37.29	35.48
9201	37.22	35.45
9202	37.29	35.2
921G	n/a	n/a
9204	37.36	35.63
821A	n/a	n/a
9203	37.4	35.66
821E	n/a	n/a
821D	n/a	n/a
811D	n/a	n/a
911D	n/a	n/a
911C	n/a	n/a
9102	36.54	34.72
9101	36.47	34.81
011A	n/a	n/a
0201	37.41	35.7
011B	n/a	n/a
011C	n/a	n/a
0101	36.48	34.83
0102	36.48	34.73

ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

Foul: A sewer designed to convey waste water from domestic and industrial sources to a treatment works.

Surface Water: A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.

Combined: A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.

Trunk Surface Water

Trunk Foul

Storm Relief

Trunk Combined

Vent Pipe

Bio-solids (Sludge)

Proposed Thames Surface Water Sewer

Proposed Thames Water Foul Sewer

Gallery

Foul Rising Main

Surface Water Rising Main

Combined Rising Main

Sludge Rising Main

Proposed Thames Water Rising Main

Vacuum

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

Air Valve

Dam Chase

Fitting

Meter

Vent Column

Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

Control Valve

Drop Pipe

Ancillary

Weir

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol, Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

Outfall

Undefined End

Inlet

Other Symbols

Symbols used on maps which do not fall under other general categories

Public/Private Pumping Station

Change of characteristic indicator (C.O.C.I.)

Invert Level

Summit

Areas

Lines denoting areas of underground surveys, etc.

Agreement

Operational Site

Chamber

Tunnel

Conduit Bridge

Other Sewer Types (Not Operated or Maintained by Thames Water)

Foul Sewer

Surface Water Sewer

Combined Sewer

Gulley

Culverted Watercourse

Proposed

Abandoned Sewer

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.
2) All measurements on the plans are metric.
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.
4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.
5) 'na' or '0' on a manhole level indicates that data is unavailable.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Insight on 0845 070 9148.

www.flood-map-for-planning.service.gov.uk

Completed
13/07/2020

Environment Agency

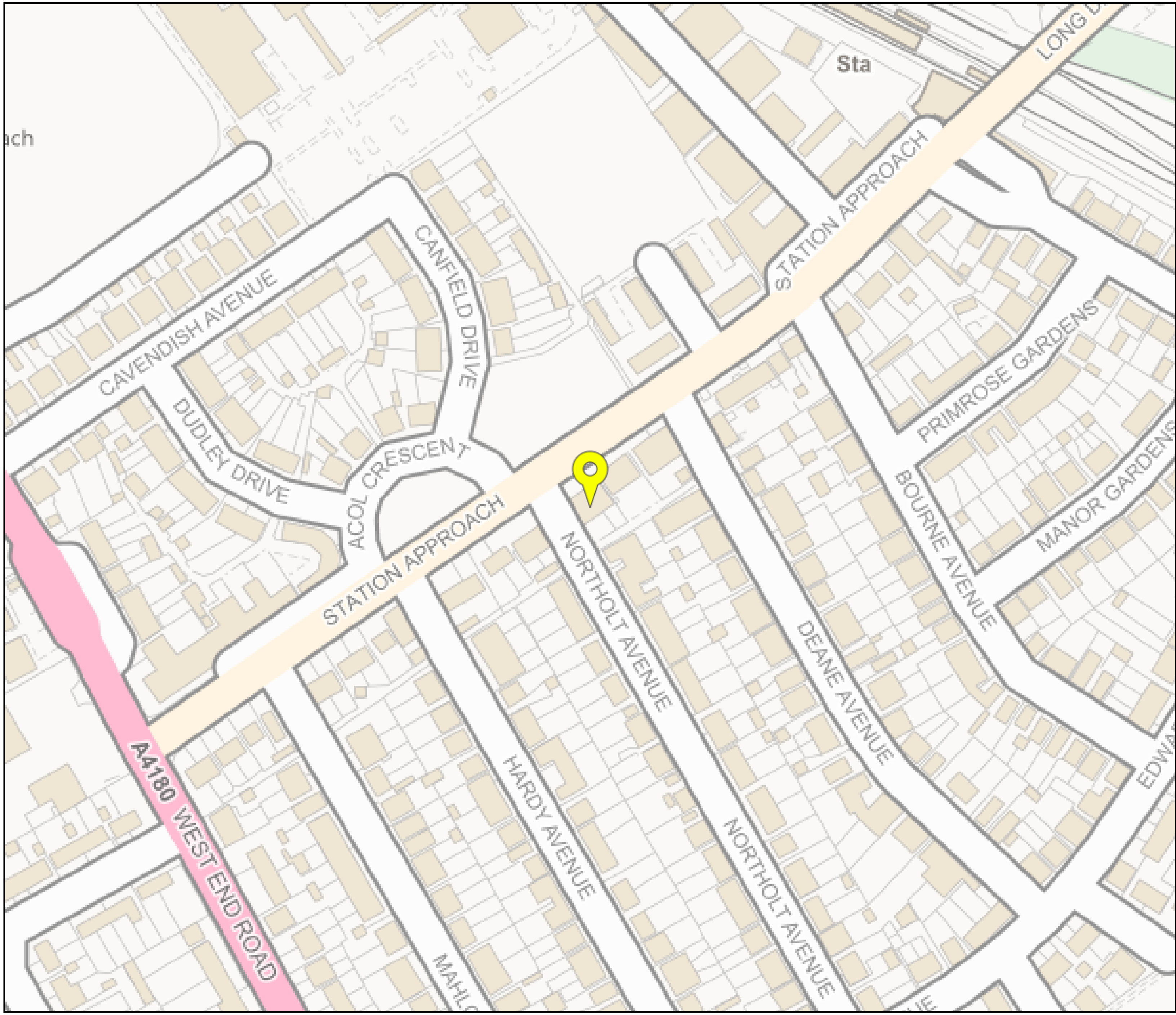
Flood map for planning

Your reference
U20-4147

Location (easting/northing)
510949/185215

Scale
1:2500

Created
29 Jun 2020 16:41



- Selected point
- Flood zone 3
- Flood zone 3: areas benefitting from flood defences
- Flood zone 2
- Flood zone 1
- Flood defence
- Main river
- Flood storage area

0 20 40 60m

Environment Agency

Flood map for planning

Your reference	Location (easting/northing)	Created
U20-4147	**510949/185215**	**29 Jun 2020 16:41**

Your selected location is in flood zone 1, an area with a low probability of flooding.

This means:

- you don't need to do a flood risk assessment if your development is smaller than 1 hectare and not affected by other sources of flooding
- you may need to do a flood risk assessment if your development is larger than 1 hectare or affected by other sources of flooding or in an area with critical drainage problems

Notes

The flood map for planning shows river and sea flooding data only. It doesn’t include other sources of flooding. It is for use in development planning and flood risk assessments.

This information relates to the selected location and is not specific to any property within it. The map is updated regularly and is correct at the time of printing.

8 Surface water flooding

Site Outline

Search buffers in metres (m)

1 in 1000 return period
- Depth between 0.1m - 0.3m
- Depth between 0.3m - 1.0m
- Depth greater than 1.0m

1 in 250 return period
- Depth between 0.1m - 0.3m
- Depth between 0.3m - 1.0m
- Depth greater than 1.0m

1 in 100 return period
- Depth between 0.1m - 0.3m
- Depth between 0.3m - 1.0m
- Depth greater than 1.0m

1 in 30 return period
- Depth between 0.1m - 0.3m
- Depth between 0.3m - 1.0m
- Depth greater than 1.0m

8.1 Surface water flooding

Highest risk on site	**Negligible**
Highest risk within 50m	**1 in 250 year, 0.1m - 0.3m**

Ambiental Risk Analytics surface water (pluvial) FloodMap identifies areas likely to flood as a result of extreme rainfall events, i.e. land naturally vulnerable to surface water ponding or flooding. This data set was produced by simulating 1 in 30 year, 1 in 100 year, 1 in 250 year and 1 in 1,000 year rainfall events. Modern urban drainage systems are typically built to cope with rainfall events between 1 in 20 and 1 in 30 years, though some older ones may flood in a 1 in 5 year rainfall event.

Features are displayed on the Surface water flooding map on **page 49**

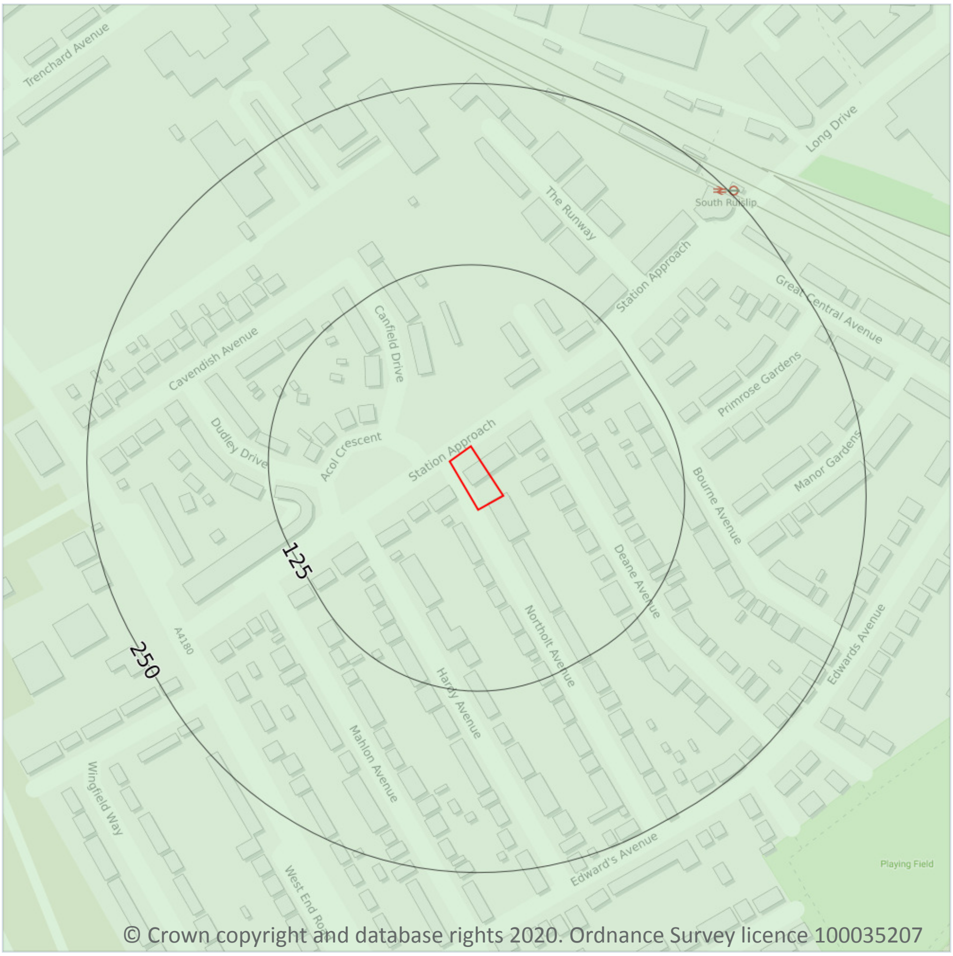
The data shown on the map and in the table above shows the highest likelihood of flood events happening at the site. Lower likelihood events may have greater flood depths and hence a greater potential impact on a site.

The table below shows the maximum flood depths for a range of return periods for the site.

Return period	Maximum modelled depth
1 in 1000 year	Negligible
1 in 250 year	Negligible
1 in 100 year	Negligible
1 in 30 year	Negligible

This data is sourced from Ambiental Risk Analytics.

9 Groundwater flooding



Site Outline

Search buffers in metres (m)

- High
- Moderate - High
- Moderate
- Low
- Negligible

9.1 Groundwater flooding

Highest risk on site	**Low**
Highest risk within 50m	**Low**

Groundwater flooding is caused by unusually high groundwater levels. It occurs when the water table rises above the ground surface or within underground structures such as basements or cellars. Groundwater flooding tends to exhibit a longer duration than surface water flooding, possibly lasting for weeks or months, and as a result it can cause significant damage to property. This risk assessment is based on a 1 in 100 year return period and a 5m Digital Terrain Model (DTM).

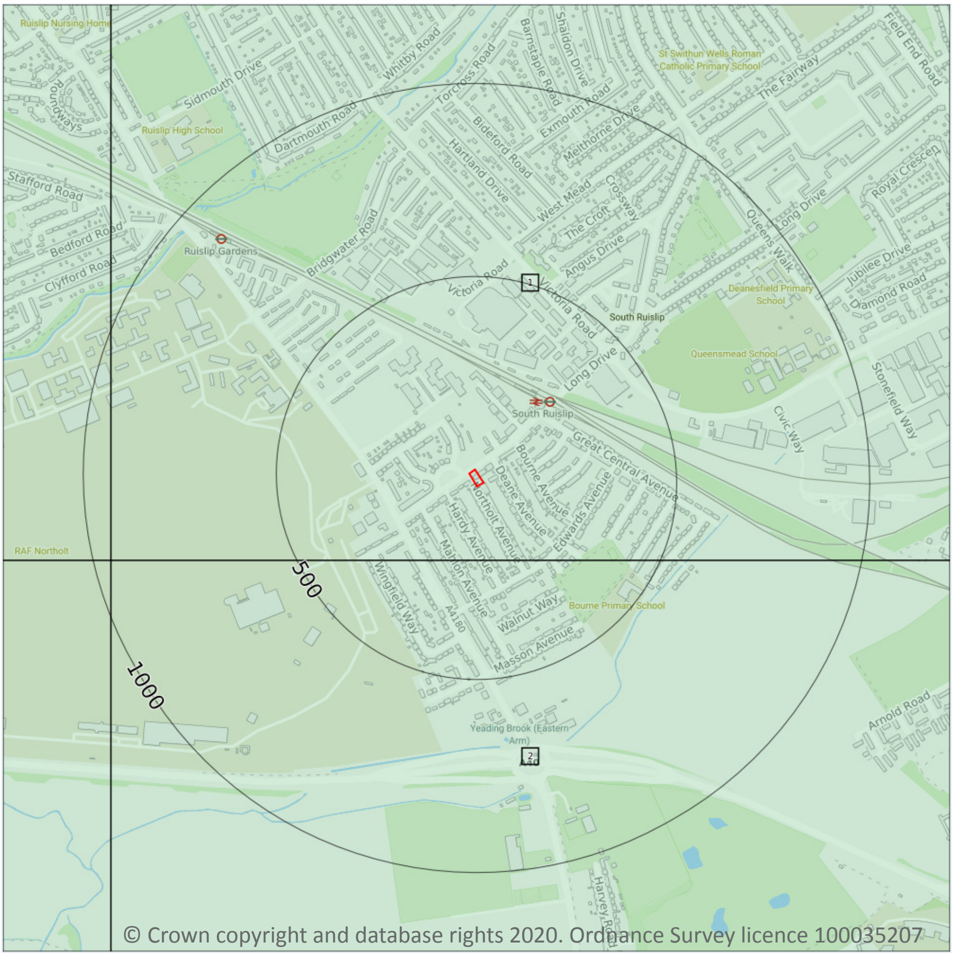
Features are displayed on the Groundwater flooding map on **page 51**

This data is sourced from Ambiental Risk Analytics.

ID	Location	Summary	Soil / surface	Superficial geology	Bedrock geology
1	**On site**	**Summary Classification: Unproductive aquifer (may have productive aquifer beneath)** **Combined classification: Unproductive Bedrock Aquifer, No Superficial Aquifer**	**Leaching class: Low** **Infiltration value: 40-70%** **Dilution value: 300-550mm/year**	**Vulnerability: -** **Aquifer type: -** **Thickness: <3m** **Patchiness value: <90%** **Recharge potential: No Data**	**Vulnerability: Unproductive** **Aquifer type: Unproductive** **Flow mechanism: Mixed**
2	34m E	Summary Classification: Unproductive aquifer (may have productive aquifer beneath) Combined classification: Unproductive Bedrock Aquifer, No Superficial Aquifer	Leaching class: Low Infiltration value: 40-70% Dilution value: 300-550mm/year	Vulnerability: - Aquifer type: - Thickness: <3m Patchiness value: <90% Recharge potential: No Data	Vulnerability: Unproductive Aquifer type: Unproductive Flow mechanism: Mixed

This data is sourced from the British Geological Survey, the Environment Agency and Natural Resources Wales.

14 Geology 1:10,000 scale - Availability



Site Outline

Search buffers in metres (m)

Full coverage

Partial coverage

No coverage

14.1 10k Availability

Records within 500m	2

An indication on the coverage of 1:10,000 scale geology data for the site, the most detailed dataset provided by the British Geological Survey. Either 'Full', 'Partial' or 'No coverage' for each geological theme.

Features are displayed on the Geology 1:10,000 scale - Availability map on **page 65**

ID	Location	Artificial	Superficial	Bedrock	Mass movement	Sheet No.
1	**On site**	**Full**	**Full**	**Full**	**No coverage**	**TQ18NW**
2	191m S	Full	Full	Full	No coverage	TQ18SW

This data is sourced from the British Geological Survey.

Geology 1:10,000 scale - Artificial and made ground

14.2 Artificial and made ground (10k)

Records within 500m	0

Details of made, worked, infilled, disturbed and landscaped ground at 1:10,000 scale. Artificial ground can be associated with potentially contaminated material, unpredictable engineering conditions and instability.

This data is sourced from the British Geological Survey.

Geology 1:10,000 scale - Superficial

14.3 Superficial geology (10k)

Records within 500m	**0**

Superficial geological deposits at 1:10,000 scale. Also known as 'drift', these are the youngest geological deposits, formed during the Quaternary. They rest on older deposits or rocks referred to as bedrock.

This data is sourced from the British Geological Survey.

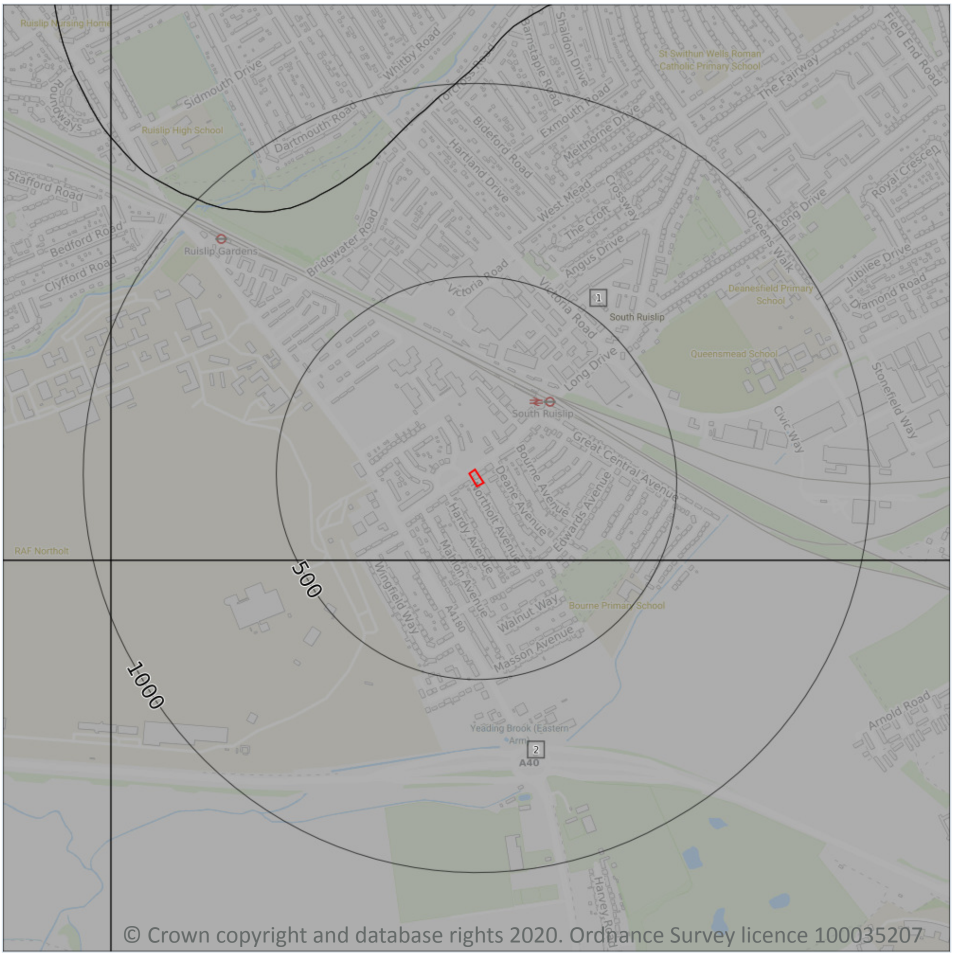
14.4 Landslip (10k)

Records within 500m	**0**

Mass movement deposits on BGS geological maps at 1:10,000 scale. Primarily superficial deposits that have moved down slope under gravity to form landslips. These affect bedrock, other superficial deposits and artificial ground.

This data is sourced from the British Geological Survey.

Geology 1:10,000 scale - Bedrock



Site Outline

Search buffers in metres (m)

Bedrock faults and other linear features (10k)

Bedrock geology (10k)
Please see table for more details.

14.5 Bedrock geology (10k)

Records within 500m	2

Bedrock geology at 1:10,000 scale. The main mass of rocks forming the Earth and present everywhere, whether exposed at the surface in outcrops or concealed beneath superficial deposits or water.

Features are displayed on the Geology 1:10,000 scale - Bedrock map on **page 68**

ID	Location	LEX Code	Description	Rock age
1	**On site**	**LC-CLAY**	**London Clay Formation - Clay**	**Eocene Epoch**
2	191m S	LC-CLAY	London Clay Formation - Clay	Eocene Epoch

This data is sourced from the British Geological Survey.

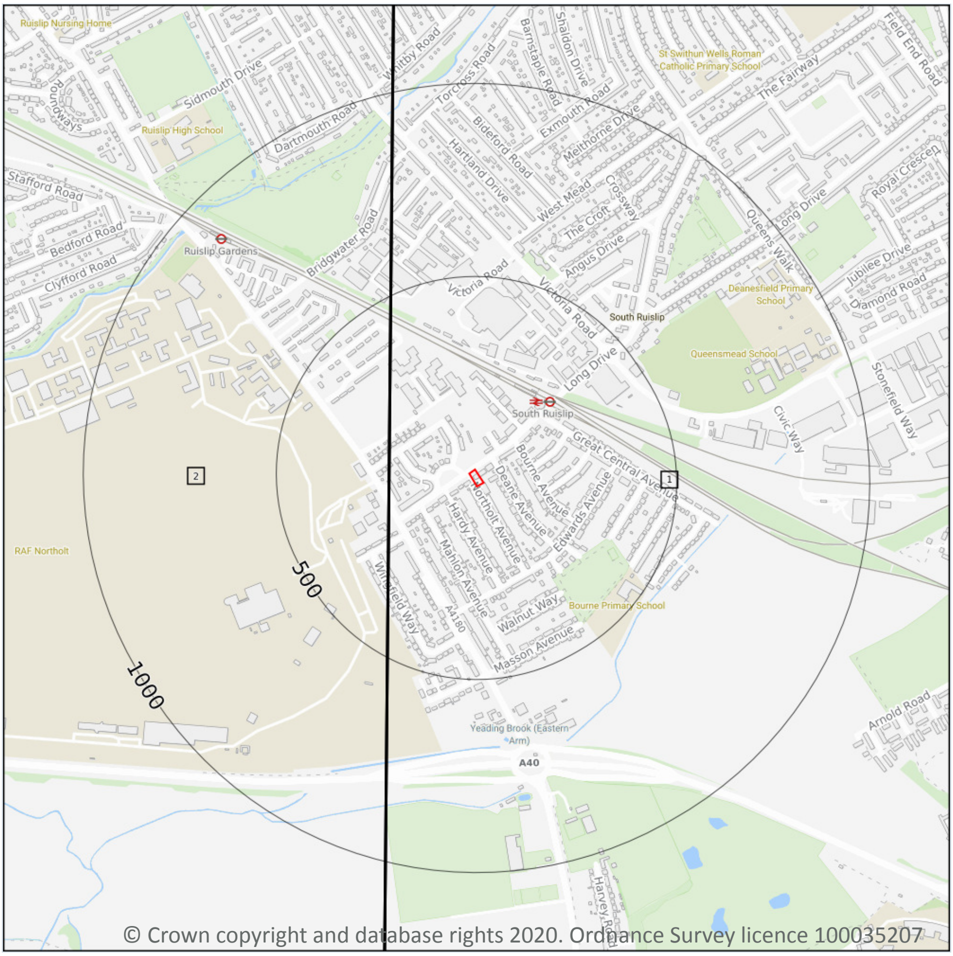
14.6 Bedrock faults and other linear features (10k)

Records within 500m	**0**

Linear features at the ground or bedrock surface at 1:10,000 scale of six main types; rock, fault, fold axis, mineral vein, alteration area or landform. Features are either observed or inferred, and relate primarily to bedrock.

This data is sourced from the British Geological Survey.

15 Geology 1:50,000 scale - Availability



Site Outline

Search buffers in metres (m)

Geological map tile

15.1 50k Availability

Records within 500m **2**

An indication on the coverage of 1:50,000 scale geology data for the site. Either 'Full' or 'No coverage' for each geological theme.

Features are displayed on the Geology 1:50,000 scale - Availability map on **page 70**

ID	Location	Artificial	Superficial	Bedrock	Mass movement	Sheet No.
1	**On site**	**Full**	**Full**	**Full**	**Full**	**EW256_north_london_v4**
2	208m W	Full	Full	Full	Full	EW255_beaconsfield_v4

This data is sourced from the British Geological Survey.

Geology 1:50,000 scale - Artificial and made ground

15.2 Artificial and made ground (50k)

Records within 500m	0

Details of made, worked, infilled, disturbed and landscaped ground at 1:50,000 scale. Artificial ground can be associated with potentially contaminated material, unpredictable engineering conditions and instability.

This data is sourced from the British Geological Survey.

15.3 Artificial ground permeability (50k)

Records within 50m	0

A qualitative classification of estimated rates of vertical movement of water from the ground surface through the unsaturated zone of any artificial deposits (the zone between the land surface and the water table).

This data is sourced from the British Geological Survey.

Geology 1:50,000 scale - Superficial

15.4 Superficial geology (50k)

Records within 500m	0

Superficial geological deposits at 1:50,000 scale. Also known as 'drift', these are the youngest geological deposits, formed during the Quaternary. They rest on older deposits or rocks referred to as bedrock.

This data is sourced from the British Geological Survey.

15.5 Superficial permeability (50k)

Records within 50m	0

A qualitative classification of estimated rates of vertical movement of water from the ground surface through the unsaturated zone of any superficial deposits (the zone between the land surface and the water table).

This data is sourced from the British Geological Survey.

15.6 Landslip (50k)

Records within 500m	0

Mass movement deposits on BGS geological maps at 1:50,000 scale. Primarily superficial deposits that have moved down slope under gravity to form landslips. These affect bedrock, other superficial deposits and artificial ground.

This data is sourced from the British Geological Survey.

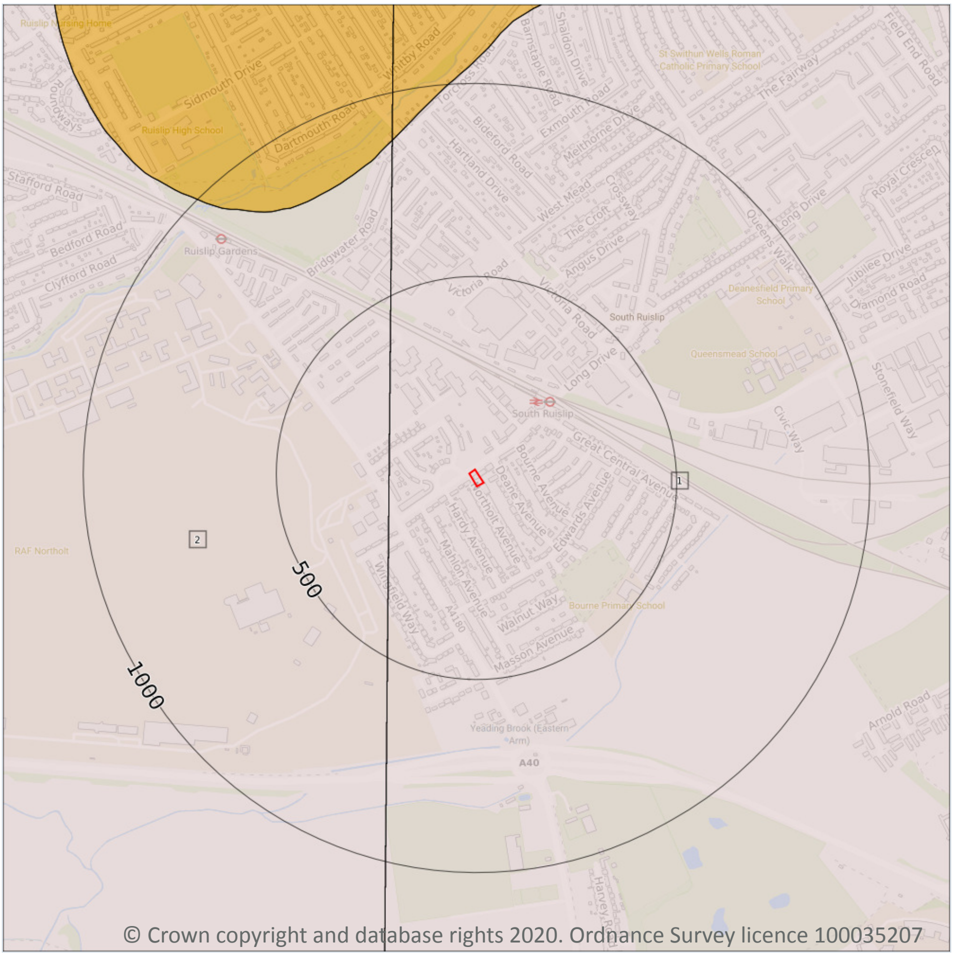
15.7 Landslip permeability (50k)

Records within 50m	0

A qualitative classification of estimated rates of vertical movement of water from the ground surface through the unsaturated zone of any landslip deposits (the zone between the land surface and the water table).

This data is sourced from the British Geological Survey.

Geology 1:50,000 scale - Bedrock



Site Outline

Search buffers in metres (m)

Bedrock faults and other linear features (50k)

Bedrock geology (50k)
Please see table for more details.

15.8 Bedrock geology (50k)

Records within 500m	2

Bedrock geology at 1:50,000 scale. The main mass of rocks forming the Earth and present everywhere, whether exposed at the surface in outcrops or concealed beneath superficial deposits or water.

Features are displayed on the Geology 1:50,000 scale - Bedrock map on **page 73**

ID	Location	LEX Code	Description	Rock age
1	**On site**	**LC-XCZS**	**LONDON CLAY FORMATION - CLAY, SILT AND SAND**	**YPRESIAN**
2	207m W	LC-XCZS	LONDON CLAY FORMATION - CLAY, SILT AND SAND	YPRESIAN

This data is sourced from the British Geological Survey.

15.9 Bedrock permeability (50k)

Records within 50m	**1**

A qualitative classification of estimated rates of vertical movement of water from the ground surface through the unsaturated zone of bedrock (the zone between the land surface and the water table).

Location	Flow type	Maximum permeability	Minimum permeability
On site	**Mixed**	**Moderate**	**Very Low**

This data is sourced from the British Geological Survey.

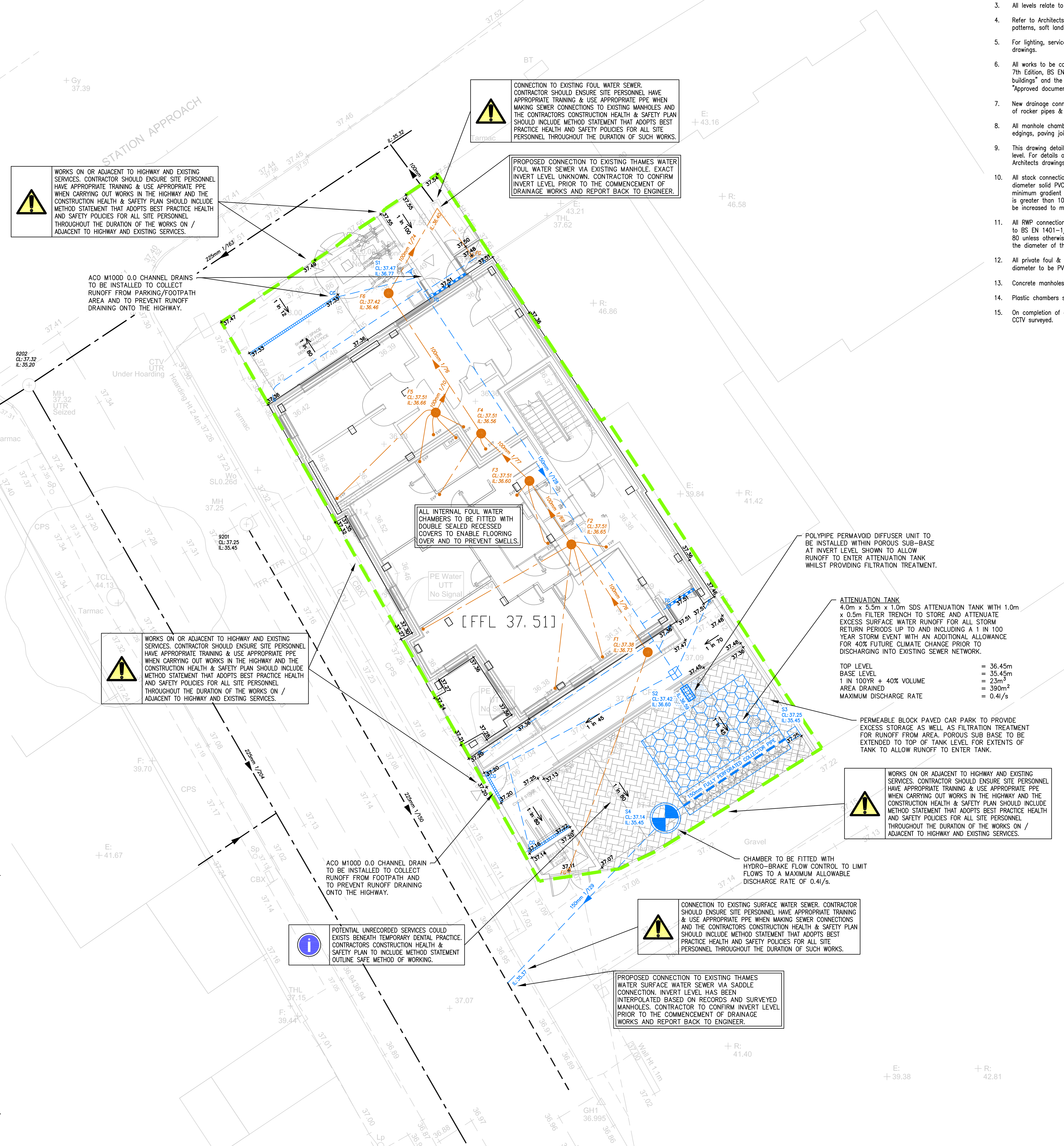
15.10 Bedrock faults and other linear features (50k)

Records within 500m	**0**

Linear features at the ground or bedrock surface at 1:50,000 scale of six main types; rock, fault, fold axis, mineral vein, alteration area or landform. Features are either observed or inferred, and relate primarily to bedrock.

This data is sourced from the British Geological Survey.

DO NOT SCALE



ENGINEERING NOTES

1. This drawing to be read in conjunction with all relevant Architects, Engineers and Subcontractors drawings and details.
2. This drawing is based on topographical survey by Greenhatch:

   Drawing Number 48127_T
   Dated 03/08/23
3. All levels relate to levels given on survey drawing.
4. Refer to Architects drawings for details of all paving types & patterns, soft landscaping, fences, gates & bollards.
5. For lighting, service supplies & ducting requirements, refer to M&E drawings.
6. All works to be carried out in accordance with Sewers for Adoption 7th Edition, BS EN 752 "Drain and sewer systems outside buildings" and the current edition of The Building Regulations "Approved document H".
7. New drainage connections are to be made with appropriate lengths of rocker pipes & couplings.
8. All manhole chamber covers to be installed parallel to final kerbs, edgings, paving joints or building lines as appropriate.
9. This drawing details all below ground drainage up to finished floor level. For details of drainage above finished floor level, refer to Architects drawings.
10. All stack connections under buildings to be minimum 100mm diameter solid PVC–U to BS EN 1401–1/BS4660 & laid at a minimum gradient of 1 in 40 unless otherwise noted. If the stack is greater than 100mm then the diameter of the connection is to be increased to match it
11. All RWP connections to be minimum 100mm diameter solid PVC–U to BS EN 1401–1/BS4660 & laid at a minimum gradient of 1 in 80 unless otherwise noted. If the RWP is greater than 100mm then the diameter of the connection is to be increased to match it.
12. All private foul & surface water pipework up to 150mm in diameter to be PVC–U to BS EN 1401–1/BS4660.
13. Concrete manholes shall comply with BS EN 1917 and BS 5911–3.
14. Plastic chambers shall comply with BS 7158.
15. On completion of development all drainage shall be jet cleaned and CCTV surveyed.

LEGEND

- Foul water gully
- Threshold drain and trapped outfall
- 150mm 1/150 — Surface water drain
- 150mm 1/80 — Foul water drain
- Foul water inspection chamber
- Surface water rodding eye
- Surface water silt trap
- Polypipe permavoid diffuser
- Surface water flow control chamber
- Permeable block paved car park
- Deepened porous sub base
- 225mm 1/150 — Existing surface water sewer
- 225mm 1/150 — Existing foul water sewer
- [FFL 37.51] — Finished floor level
- 37.35 — Proposed level
- 1 in 45 — Proposed gradient
- 37.60 — Existing level
- Site boundary
- ADVISORY NOTE FOR INFORMATION
- DENOTES RESIDUAL RISK AS WARNING

DESIGNERS RESIDUAL RISK SCHEDULE

CONSTRUCTION

1. EXISTING SEWERS / DRAINAGE / SERVICES / OVERHEAD CABLES:

a. REFER TO EXISTING SERVICES LAYOUT (REF: P22–1031:100) / TOPOGRAPHICAL SURVEY (REF: 48127_T_UG) / STATUTORY UNDERTAKERS RECORDS FOR LOCATION OF EXISTING SEWERS / DRAINAGE / SERVICES & OVERHEAD CABLES.

b. WORKS IN CLOSE PROXIMITY TO EXISTING SEWERS / DRAINAGE / SERVICES / OVERHEAD CABLES. CONTRACTORS CONSTRUCTION HEALTH & SAFETY PLAN SHOULD INCLUDE METHOD STATEMENT OUTLINING SAFE METHOD OF WORKING AGREED WITH RELEVANT STATUTORY UNDERTAKER WHERE NECESSARY.

c. WORKS AFFECTED BY EXISTING SEWERS / DRAINAGE / SERVICES / OVERHEAD CABLES. CONTRACTOR SHOULD ARRANGE FOR DIVERSION / LOWERING / PROTECTION BY STATUTORY UNDERTAKER WHERE NECESSARY PRIOR TO COMMENCEMENT OF WORKS.

2. GROUND CONDITIONS / SOIL CONTAMINATION / REMEDIATION

a. THE GROUND INVESTIGATION REPORT (REF: J22065) DID NOT IDENTIFY SOIL CONTAMINATION TO BE PRESENT. HOWEVER, CONTRACTOR SHOULD ENSURE SITE PERSONNEL USE APPROPRIATE PPE WHEN CARRYING OUT EXCAVATIONS & THAT CONSTRUCTION HEALTH & SAFETY PLAN INCLUDES METHOD STATEMENT FOR DEALING WITH UNFORESEEN CONTAMINATION IF ENCOUNTERED DURING WORKS.

b. SITE WAS PREVIOUSLY OCCUPIED BY BUILDINGS & STRUCTURES. WHILST TO DATE SITE INVESTIGATIONSE HAVE NOT IDENTIFIED ANY EVIDENCE OF CONTAMINATION OR FORMER FOUNDATIONS IT IS POSSIBLE THAT CONTAMINATION / OBSTRUCTIONS MAY STILL EXIST & BE ENCOUNTERED DURING WORKS. CONTRACTOR SHOULD ENSURE SITE PERSONNEL USE APPROPRIATE PPE WHEN CARRYING OUT EXCAVATIONS & THAT CONSTRUCTION HEALTH & SAFETY PLAN INCLUDES METHOD STATEMENT FOR DEALING WITH UNFORESEEN CONTAMINATION / OBSTRUCTIONS IF ENCOUNTERED DURING WORKS. WHERE GROUND CONDITIONS DEVIATE FROM THOSE REPORTED IN THE SITE INVESTIGATION REPORT, THE ENGINEER SHOULD BE CONTACTED IMMEDIATELY FOR ADVICE ON HOW TO PROCEED.

3. EXCAVATIONS & EARTHWORKS

a. REFER TO GROUND INVESTIGATION REPORT (REF: J22065) FOR DETAILS OF UNDERLYING SOILS. WHERE GROUND CONDITIONS ARE FOUND TO DEVIATE FROM THOSE REPORTED IN THE SITE INVESTIGATION REPORT, THE ENGINEER SHOULD BE CONTACTED IMMEDIATELY FOR ADVICE ON HOW TO PROCEED.

b. EXCAVATIONS WHERE ACCESS IS REQUIRED SHOULD BE TEMPORARY SUPPORTED WITH SLOPES BATTERED WELL BACK AND MAINTAINED AT A SAFE ANGLE.

c. CONTRACTORS CONSTRUCTION HEALTH & SAFETY PLAN SHOULD INCLUDE METHOD STATEMENT OUTLINING SAFE METHOD OF WORKING IN OR ADJACENT TO DEEP EXCAVATIONS ADJACENT TO BOUNDARIES / STRUCTURES / EMBANKMENTS / BULK EARTHWORKS.

4. WORKS ON OR ADJACENT TO HIGHWAY

a. CONTRACTOR SHOULD ENSURE SITE PERSONNEL HAVE APPROPRIATE TRAINING & USE APPROPRIATE PPE WHEN CARRYING OUT WORKS IN THE HIGHWAY AND THE CONSTRUCTION HEALTH & SAFETY PLAN SHOULD INCLUDE METHOD STATEMENT THAT ADOPTS BEST PRACTICE HEALTH AND SAFETY POLICIES FOR ALL SITE PERSONNEL THROUGHOUT THE DURATION OF THE WORKS ON / ADJACENT TO HIGHWAY.

5. CONNECTING TO EXISTING MANHOLES / SEWERS

a. CONTRACTORS CONSTRUCTION HEALTH & SAFETY PLAN SHOULD INCLUDE METHOD STATEMENT THAT ADOPTS BEST PRACTICE HEALTH AND SAFETY POLICIES FOR ALL SITE PERSONNEL THROUGHOUT THE DURATION OF SUCH WORKS.

b. CONTRACTOR SHOULD ENSURE SITE PERSONNEL HAVE APPROPRIATE TRAINING & USE APPROPRIATE PPE WHEN MAKING SEWER CONNECTIONS TO EXISTING MANHOLES / SEWERS.

MK	REVISION	BY	DATE
T2	EXTERNAL LEVELS ADJUSTED SLIGHTLY AND CHANNEL DRAINS NEAR DOORS UPDATED TO THRESHOLD DRAINS AT DOORS.	PB	19.10.23
T1	FIRST ISSUE.	PB	08.09.23

DRAWING STATUS

NOT FOR CONSTRUCTION

DRAWING TITLE

ENGINEERING LAYOUT

PROJECT

40 STATION APPROACH
RUISLIP
HA4 6RZ

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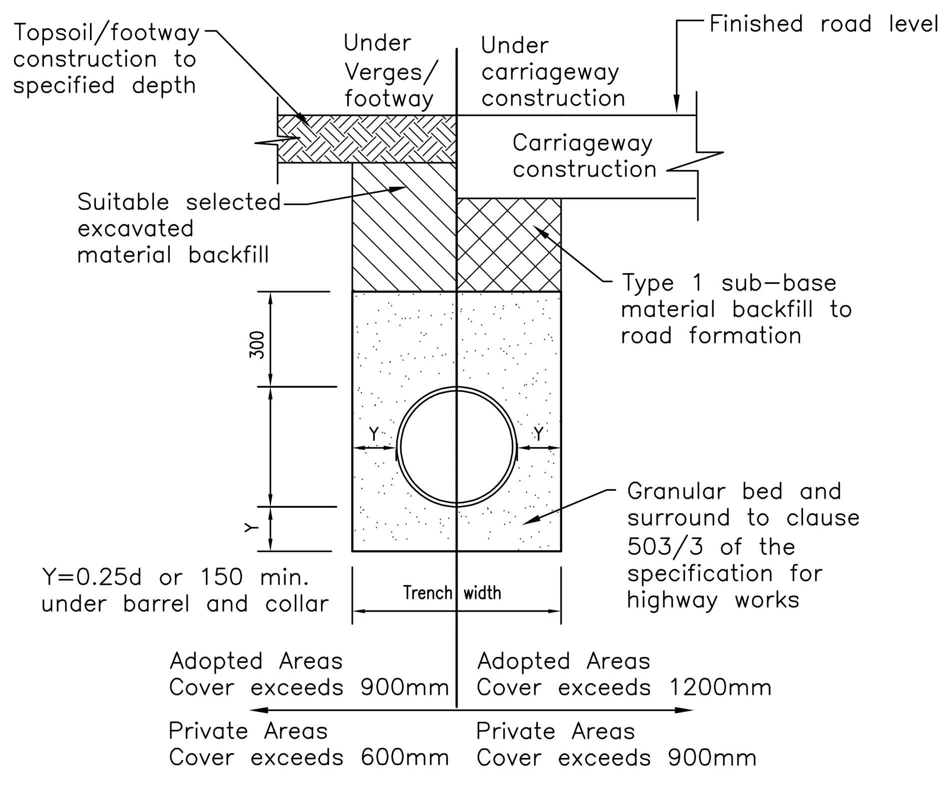
Drawn	Ch'kd	Scales	Date
PB	AR	1:100 @ A1	SEPT '23

Purpose of Issue: TENDER

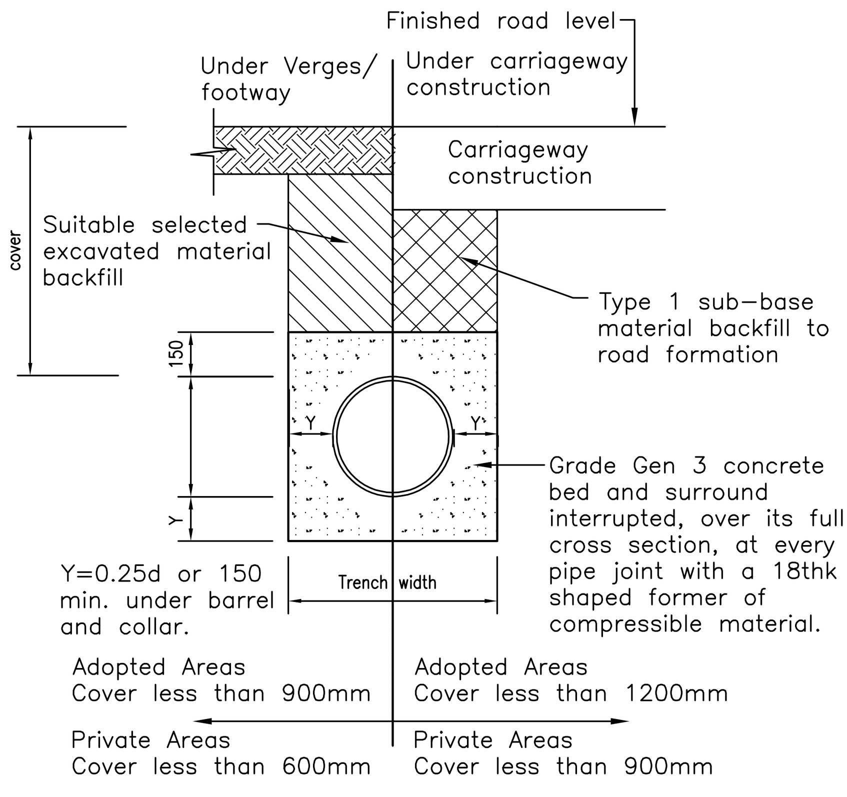
Project Number	Drawing Number	Revision
P22-1031	101	T2

A1

DO NOT SCALE

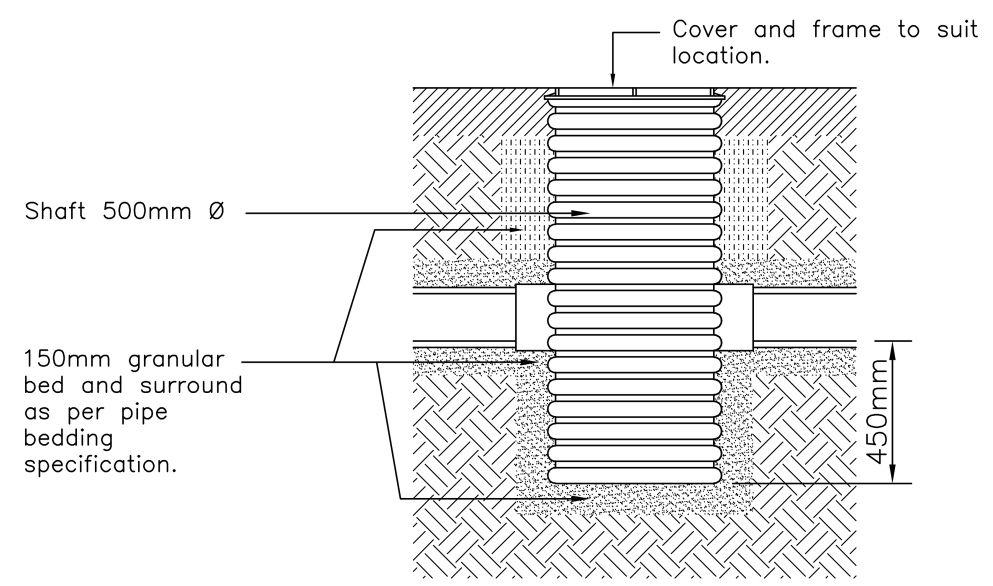


Class S Granular Surround



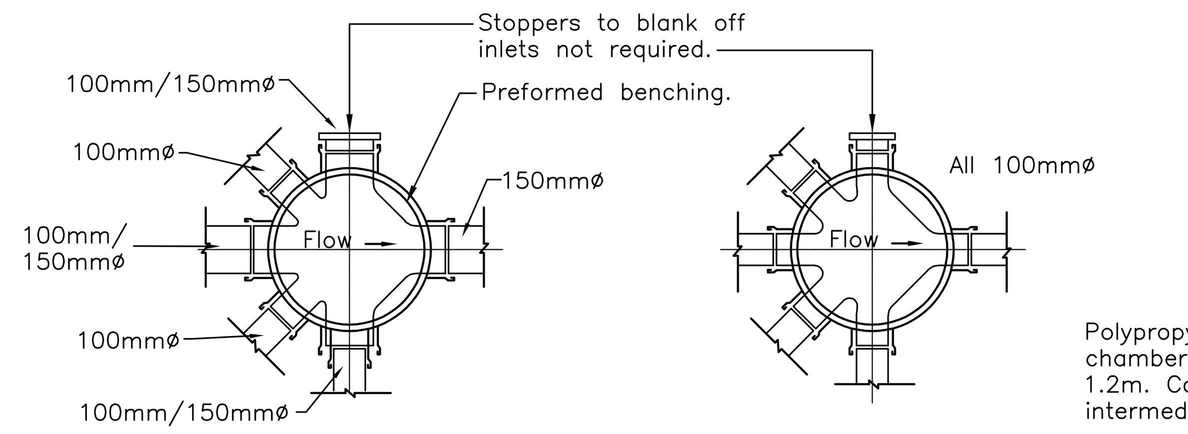
Class Z Concrete surround

PIPE BEDDING DETAILS



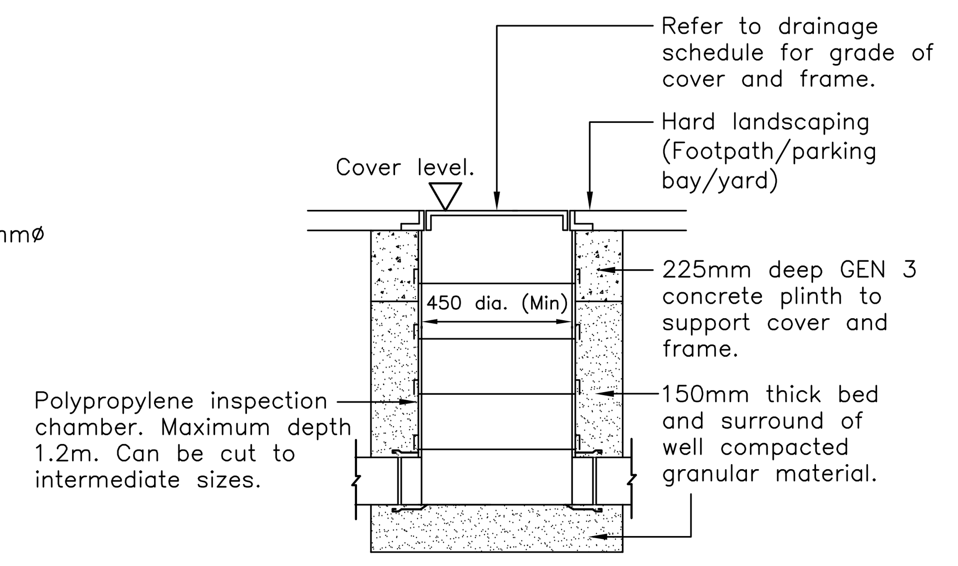
SILT TRAP

N.B TO BE INSTALLED TO MANUFACTURES SPECIFICATION.



NOTE

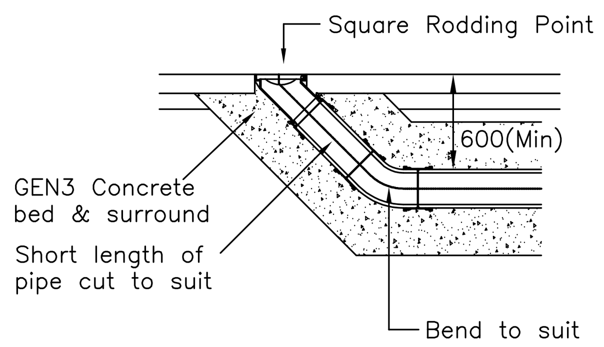
Private drainage to be constructed in accordance with the Building Regulations "Approved Document H".



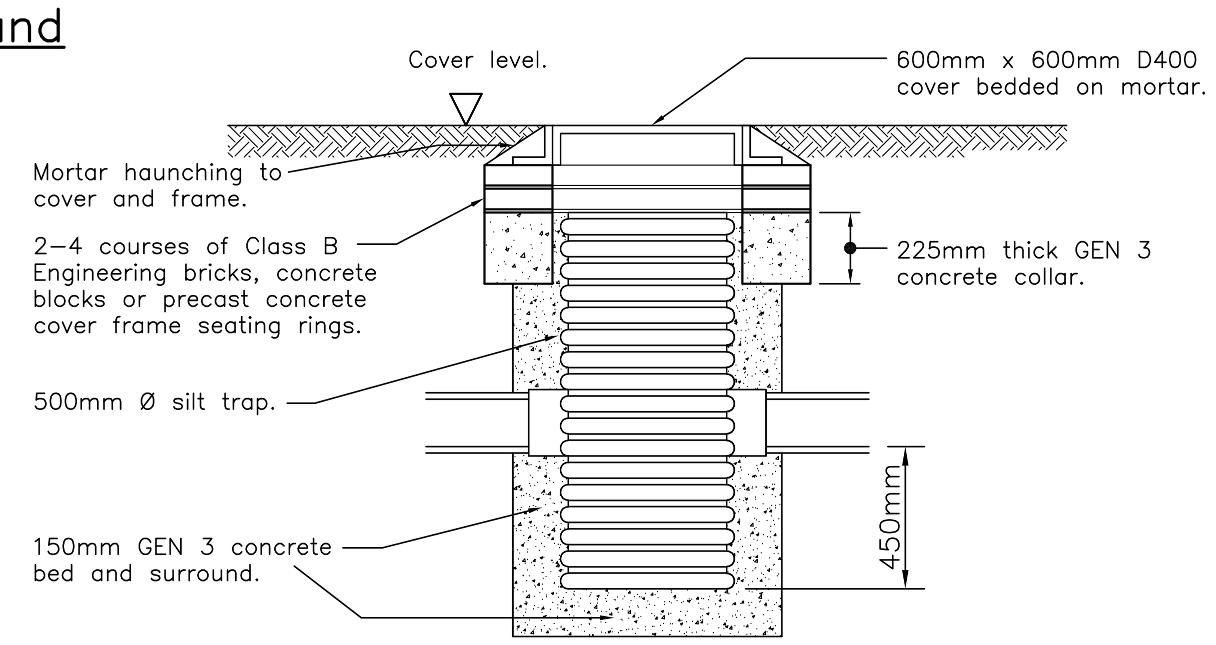
UIC SITED IN HARD LANDSCAPING

UNIVERSAL INSPECTION CHAMBER (UIC) – POLYPROPYLENE

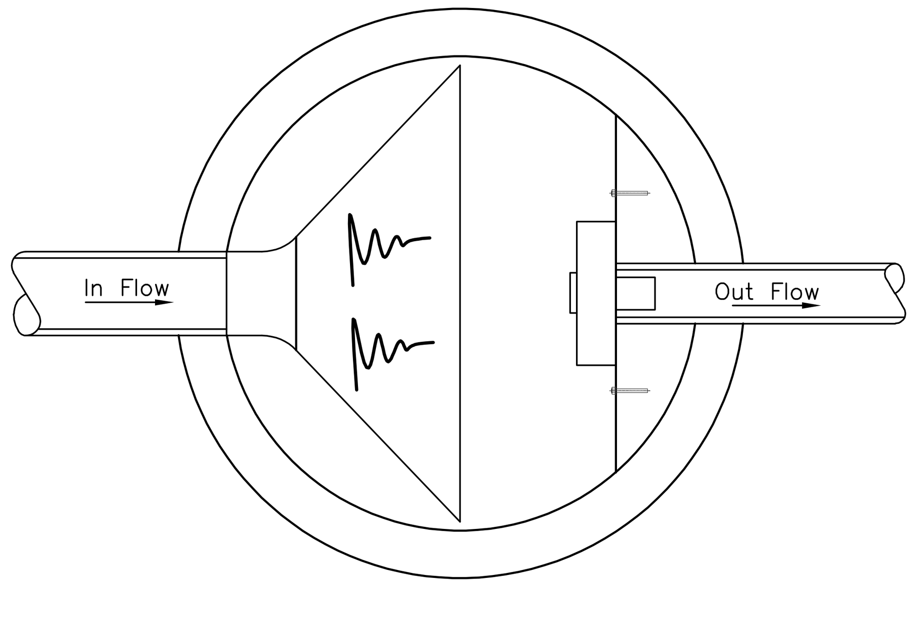
Max. Depth from cover level to invert of pipe 1.2m



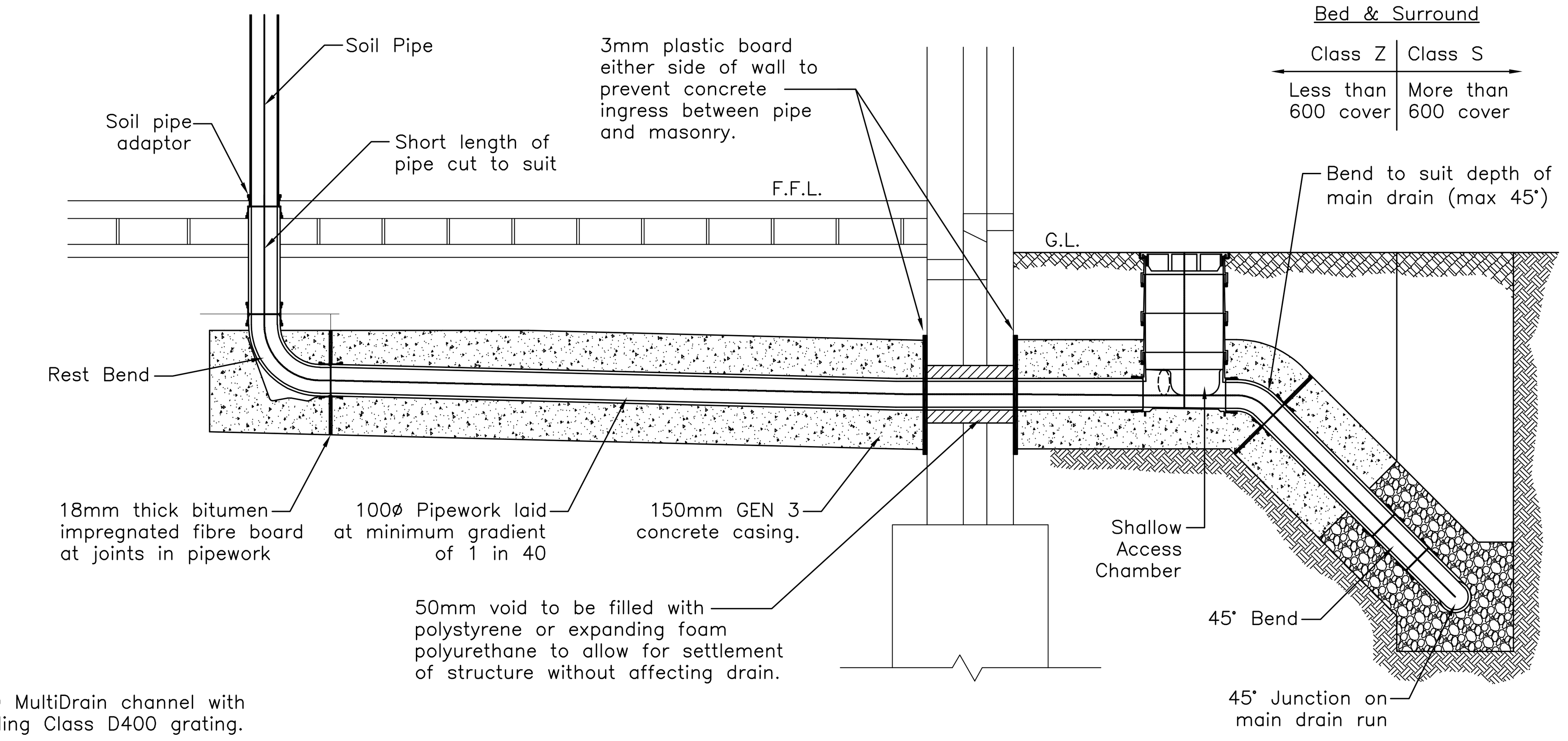
RODDING POINT INSTALLATION DETAILS



SILT TRAP WITH A HEAVY DUTY D400 COVER

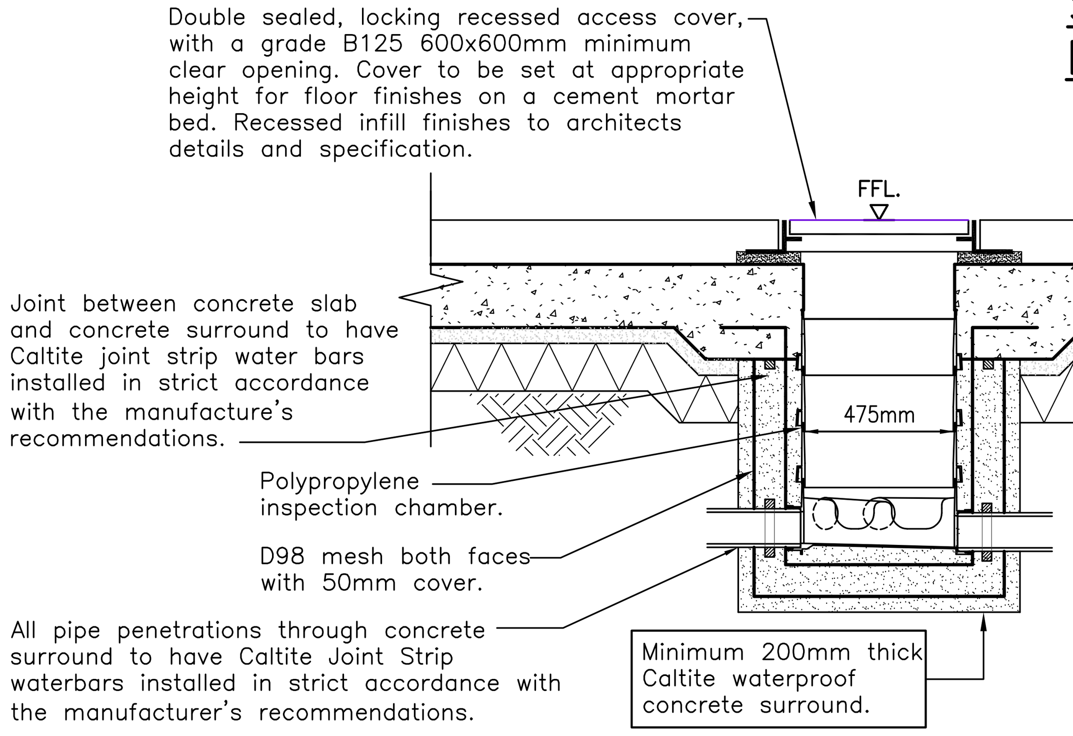


Hydrobrake Chamber (Plan)



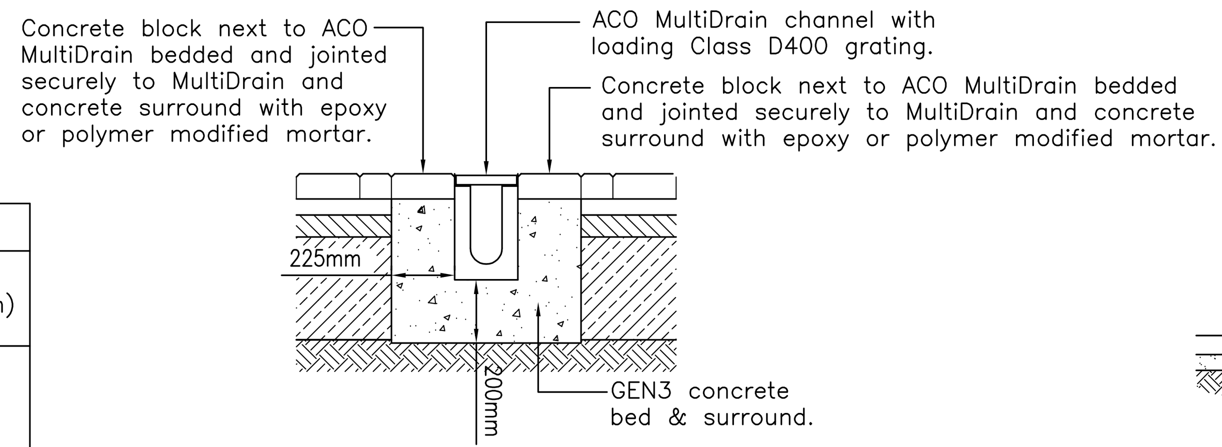
Bed & Surround	
Class Z	Class S
Less than 600 cover	More than 600 cover

TYPICAL SOIL VENT PIPE & EXTERNAL CHAMBER DETAIL

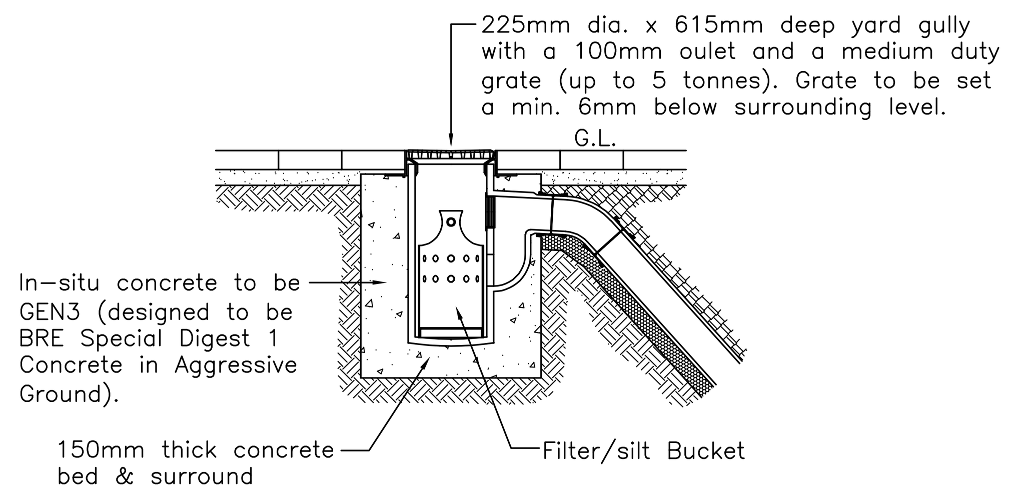


Rocker Pipes	
Nominal dia. (mm)	Effective length (m)
150 – 600	0.6
601 – 750	1.0
Over 750	1.25

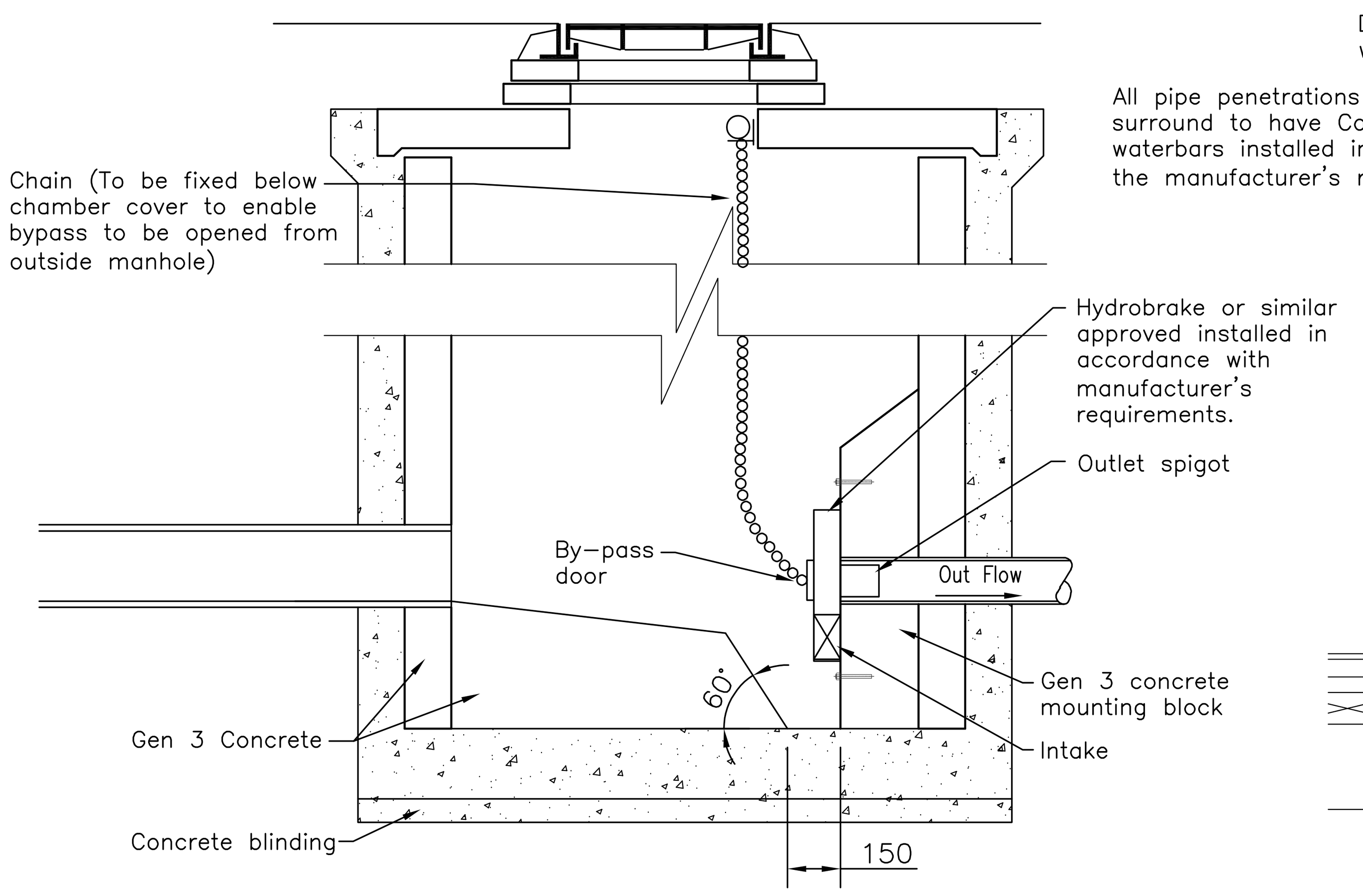
INTERNAL POLYPROPYLENE INSPECTION CHAMBER WITH A DOUBLE SEALED, RECESSED ACCESS COVER



ACO M100D 0.0 CHANNEL WITHIN BLOCK PAVING



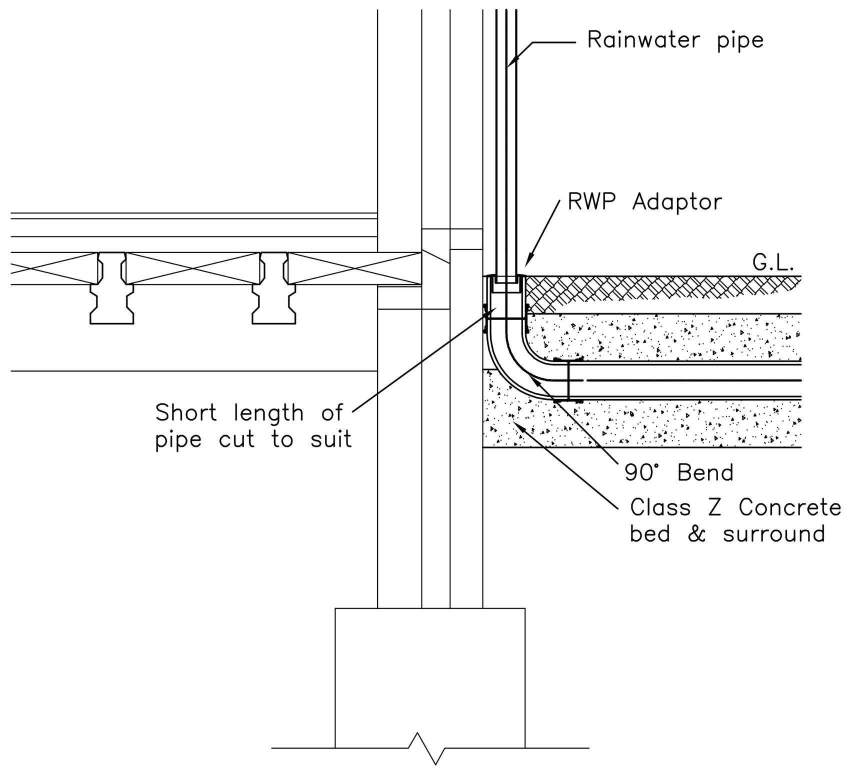
YARD GULLY



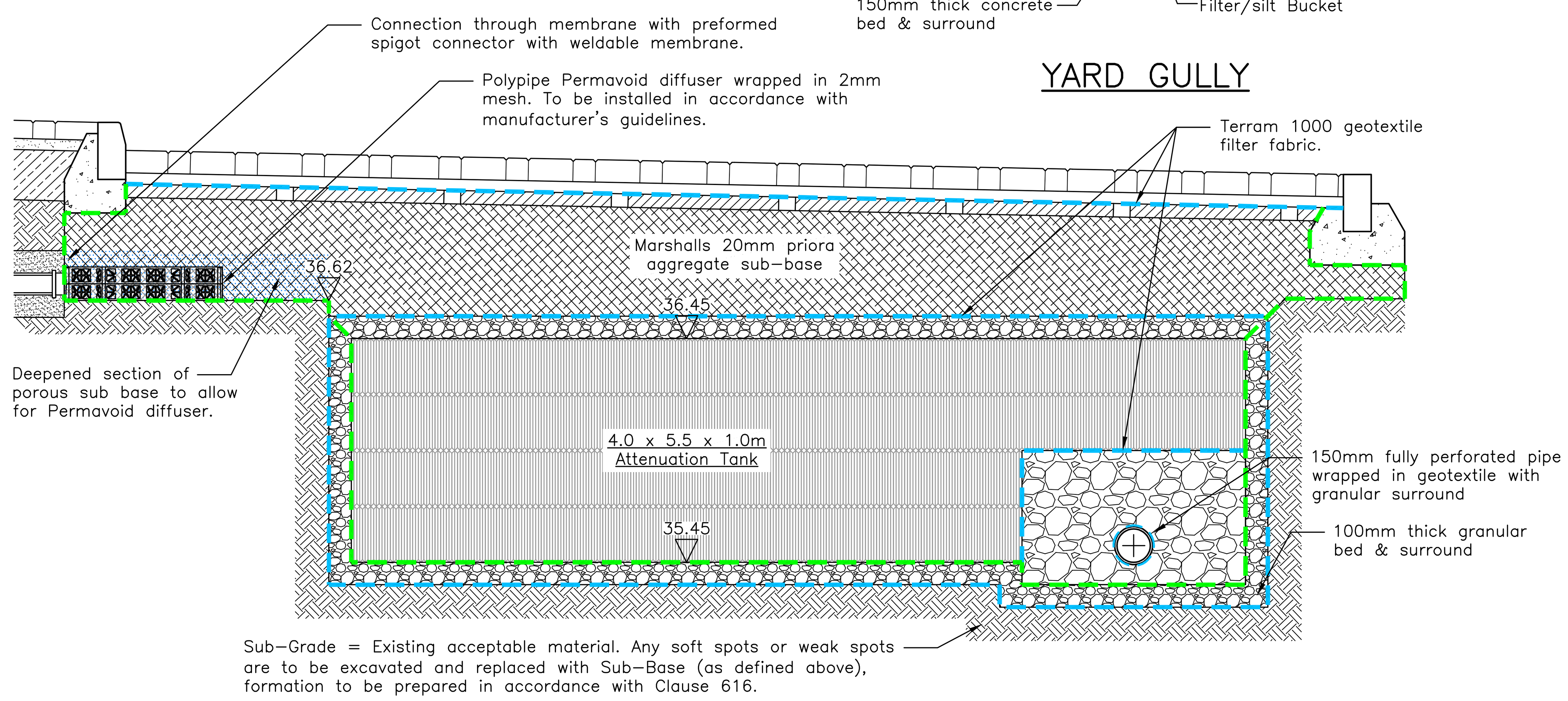
Hydrobrake Chamber (Section)

Notes:

1. Chamber cover to be positioned directly above by-pass door.
2. Dimensions are indicative only and are dependant on type of control device used. Refer to manufacturer's specifications for details.
3. Hydrobrake flow control chamber to limit flows to 0.4 l/s for all storm events up to & including the 1 in 100 year storm plus 40% allowance for climate change.
   hydrobrake type – MD-SHE-0026-4000-1500-4000
   design head – 1.50m
   orifice diameter – 0.026m
4. For chamber construction details refer to surface water catchpit manhole construction details.



EXTERNAL RAINWATER PIPE CONNECTION DETAIL



SECTION THROUGH ATTENUATION TANK, PERMEABLE PAVING & PERMAVOID DIFFUSER

T1	FIRST ISSUE.	PB	08.09.23
MK	REVISION	BY	DATE

DRAWING STATUS
NOT FOR CONSTRUCTION

DRAWING TITLE
DRAINAGE DETAILS

PROJECT
40 STATION APPROACH
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Drawn	Ch'kd	Scales	Date
PB	AR	NTS	SEPT '23

Purpose of Issue
TENDER

Project Number	Drawing Number	Revision
P22-1031	103	T1

A1

Summary of Results for 1 year Return Period

Half Drain Time : 174 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	35.544	0.094	0.0	0.2	0.2	1.9	O K
30 min Summer	35.572	0.122	0.0	0.2	0.2	2.5	O K
60 min Summer	35.599	0.149	0.0	0.2	0.2	3.0	O K
120 min Summer	35.619	0.169	0.0	0.2	0.2	3.4	O K
180 min Summer	35.625	0.175	0.0	0.2	0.2	3.6	O K
240 min Summer	35.628	0.178	0.0	0.2	0.2	3.6	O K
360 min Summer	35.627	0.177	0.0	0.2	0.2	3.6	O K
480 min Summer	35.621	0.171	0.0	0.2	0.2	3.5	O K
600 min Summer	35.614	0.164	0.0	0.2	0.2	3.3	O K
720 min Summer	35.606	0.156	0.0	0.2	0.2	3.2	O K
960 min Summer	35.589	0.139	0.0	0.2	0.2	2.8	O K
1440 min Summer	35.561	0.111	0.0	0.2	0.2	2.3	O K
2160 min Summer	35.530	0.080	0.0	0.2	0.2	1.6	O K
2880 min Summer	35.510	0.060	0.0	0.2	0.2	1.2	O K
4320 min Summer	35.492	0.042	0.0	0.2	0.2	0.9	O K
5760 min Summer	35.484	0.034	0.0	0.1	0.1	0.7	O K
7200 min Summer	35.479	0.029	0.0	0.1	0.1	0.6	O K
8640 min Summer	35.475	0.025	0.0	0.1	0.1	0.5	O K
10080 min Summer	35.473	0.023	0.0	0.1	0.1	0.5	O K
15 min Winter	35.557	0.107	0.0	0.2	0.2	2.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	32.000	0.0	2.0	18
30 min Summer	20.793	0.0	2.7	32
60 min Summer	13.089	0.0	3.5	62
120 min Summer	8.069	0.0	4.4	120
180 min Summer	6.050	0.0	5.0	152
240 min Summer	4.927	0.0	5.4	184
360 min Summer	3.662	0.0	6.1	250
480 min Summer	2.961	0.0	6.6	320
600 min Summer	2.510	0.0	7.0	386
720 min Summer	2.193	0.0	7.3	456
960 min Summer	1.773	0.0	7.9	586
1440 min Summer	1.314	0.0	8.7	838
2160 min Summer	0.974	0.0	9.7	1188
2880 min Summer	0.787	0.0	10.4	1528
4320 min Summer	0.583	0.0	11.4	2244
5760 min Summer	0.471	0.0	12.2	2944
7200 min Summer	0.400	0.0	12.8	3672
8640 min Summer	0.350	0.0	13.3	4408
10080 min Summer	0.312	0.0	13.8	5128
15 min Winter	32.000	0.0	2.3	18

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	35.590	0.140	0.0	0.2	0.2	2.9	O K
60 min Winter	35.622	0.172	0.0	0.2	0.2	3.5	O K
120 min Winter	35.646	0.196	0.0	0.2	0.2	4.0	O K
180 min Winter	35.654	0.204	0.0	0.2	0.2	4.1	O K
240 min Winter	35.655	0.205	0.0	0.2	0.2	4.2	O K
360 min Winter	35.651	0.201	0.0	0.2	0.2	4.1	O K
480 min Winter	35.641	0.191	0.0	0.2	0.2	3.9	O K
600 min Winter	35.629	0.179	0.0	0.2	0.2	3.6	O K
720 min Winter	35.616	0.166	0.0	0.2	0.2	3.4	O K
960 min Winter	35.590	0.140	0.0	0.2	0.2	2.9	O K
1440 min Winter	35.547	0.097	0.0	0.2	0.2	2.0	O K
2160 min Winter	35.508	0.058	0.0	0.2	0.2	1.2	O K
2880 min Winter	35.494	0.044	0.0	0.2	0.2	0.9	O K
4320 min Winter	35.481	0.031	0.0	0.1	0.1	0.6	O K
5760 min Winter	35.475	0.025	0.0	0.1	0.1	0.5	O K
7200 min Winter	35.472	0.022	0.0	0.1	0.1	0.4	O K
8640 min Winter	35.470	0.020	0.0	0.1	0.1	0.4	O K
10080 min Winter	35.468	0.018	0.0	0.1	0.1	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	20.793	0.0	3.1	32
60 min Winter	13.089	0.0	4.0	60
120 min Winter	8.069	0.0	5.0	118
180 min Winter	6.050	0.0	5.6	172
240 min Winter	4.927	0.0	6.1	202
360 min Winter	3.662	0.0	6.8	274
480 min Winter	2.961	0.0	7.4	350
600 min Winter	2.510	0.0	7.8	422
720 min Winter	2.193	0.0	8.2	494
960 min Winter	1.773	0.0	8.9	628
1440 min Winter	1.314	0.0	9.8	878
2160 min Winter	0.974	0.0	10.9	1208
2880 min Winter	0.787	0.0	11.7	1528
4320 min Winter	0.583	0.0	12.9	2248
5760 min Winter	0.471	0.0	13.8	2952
7200 min Winter	0.400	0.0	14.5	3592
8640 min Winter	0.350	0.0	15.1	4296
10080 min Winter	0.312	0.0	15.6	5112

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.400	Shortest Storm (mins)	15
Ratio R	0.414	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.039

Time From:	(mins) To:	Area (ha)
0	4	0.039

Model Details

Storage is Online Cover Level (m) 37.070

Complex Structure

Cellular Storage

Invert Level (m)	35.450	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.95
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	19.3	19.3	1.001	0.0	37.3
1.000	19.3	37.3			

Filter Drain

Infiltration Coefficient Base (m/hr)	0.00000	Pipe Diameter (m)	0.150
Infiltration Coefficient Side (m/hr)	0.00000	Pipe Depth above Invert (m)	0.000
Safety Factor	2.0	Slope (1:X)	0.0
Porosity	0.30	Cap Volume Depth (m)	0.500
Invert Level (m)	35.450	Cap Infiltration Depth (m)	0.000
Trench Width (m)	1.0	Number of Pipes	1
Trench Length (m)	5.5		

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	12.0
Max Percolation (l/s)	16.7	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	36.620	Cap Volume Depth (m)	0.240

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0026-4000-1500-4000
Design Head (m)	1.500
Design Flow (l/s)	0.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	26
Invert Level (m)	35.450
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Hydro-Brake® Optimum Outflow Control

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	0.4
Flush-Flo™	0.115	0.2
Kick-Flo®	0.233	0.2
Mean Flow over Head Range	-	0.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.2	1.200	0.4	3.000	0.5	7.000	0.8
0.200	0.2	1.400	0.4	3.500	0.6	7.500	0.8
0.300	0.2	1.600	0.4	4.000	0.6	8.000	0.8
0.400	0.2	1.800	0.4	4.500	0.6	8.500	0.9
0.500	0.2	2.000	0.5	5.000	0.7	9.000	0.9
0.600	0.3	2.200	0.5	5.500	0.7	9.500	0.9
0.800	0.3	2.400	0.5	6.000	0.7		
1.000	0.3	2.600	0.5	6.500	0.8		

Summary of Results for 30 year Return Period

Half Drain Time : 415 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	35.712	0.262	0.0	0.2	0.2	5.3	O K
30 min Summer	35.790	0.340	0.0	0.2	0.2	6.8	O K
60 min Summer	35.861	0.411	0.0	0.2	0.2	8.3	O K
120 min Summer	35.920	0.470	0.0	0.2	0.2	9.4	O K
180 min Summer	35.942	0.492	0.0	0.2	0.2	9.9	O K
240 min Summer	35.948	0.498	0.0	0.2	0.2	10.0	O K
360 min Summer	35.942	0.492	0.0	0.2	0.2	9.9	O K
480 min Summer	35.934	0.484	0.0	0.2	0.2	9.7	O K
600 min Summer	35.924	0.474	0.0	0.2	0.2	9.5	O K
720 min Summer	35.913	0.463	0.0	0.2	0.2	9.3	O K
960 min Summer	35.890	0.440	0.0	0.2	0.2	8.8	O K
1440 min Summer	35.846	0.396	0.0	0.2	0.2	8.0	O K
2160 min Summer	35.787	0.337	0.0	0.2	0.2	6.8	O K
2880 min Summer	35.733	0.283	0.0	0.2	0.2	5.7	O K
4320 min Summer	35.624	0.174	0.0	0.2	0.2	3.5	O K
5760 min Summer	35.557	0.107	0.0	0.2	0.2	2.2	O K
7200 min Summer	35.521	0.071	0.0	0.2	0.2	1.5	O K
8640 min Summer	35.503	0.053	0.0	0.2	0.2	1.1	O K
10080 min Summer	35.495	0.045	0.0	0.2	0.2	0.9	O K
15 min Winter	35.746	0.296	0.0	0.2	0.2	6.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	78.552	0.0	5.4	19
30 min Summer	50.836	0.0	7.1	33
60 min Summer	31.437	0.0	8.9	62
120 min Summer	18.865	0.0	10.7	122
180 min Summer	13.846	0.0	11.8	182
240 min Summer	11.071	0.0	12.6	240
360 min Summer	8.064	0.0	13.8	316
480 min Summer	6.437	0.0	14.7	380
600 min Summer	5.401	0.0	15.4	442
720 min Summer	4.678	0.0	16.0	508
960 min Summer	3.727	0.0	17.0	646
1440 min Summer	2.703	0.0	18.5	924
2160 min Summer	1.958	0.0	20.0	1340
2880 min Summer	1.557	0.0	21.2	1732
4320 min Summer	1.126	0.0	22.9	2460
5760 min Summer	0.894	0.0	24.1	3112
7200 min Summer	0.747	0.0	25.0	3752
8640 min Summer	0.645	0.0	25.8	4416
10080 min Summer	0.570	0.0	26.4	5144
15 min Winter	78.552	0.0	6.1	19

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	35.834	0.384	0.0	0.2	0.2	7.7	O K
60 min Winter	35.916	0.466	0.0	0.2	0.2	9.4	O K
120 min Winter	35.988	0.538	0.0	0.3	0.3	10.7	O K
180 min Winter	36.018	0.568	0.0	0.3	0.3	11.3	O K
240 min Winter	36.029	0.579	0.0	0.3	0.3	11.5	O K
360 min Winter	36.028	0.578	0.0	0.3	0.3	11.5	O K
480 min Winter	36.013	0.563	0.0	0.3	0.3	11.2	O K
600 min Winter	36.000	0.550	0.0	0.3	0.3	11.0	O K
720 min Winter	35.985	0.535	0.0	0.3	0.3	10.7	O K
960 min Winter	35.951	0.501	0.0	0.3	0.3	10.1	O K
1440 min Winter	35.887	0.437	0.0	0.2	0.2	8.8	O K
2160 min Winter	35.799	0.349	0.0	0.2	0.2	7.0	O K
2880 min Winter	35.718	0.268	0.0	0.2	0.2	5.4	O K
4320 min Winter	35.564	0.114	0.0	0.2	0.2	2.3	O K
5760 min Winter	35.507	0.057	0.0	0.2	0.2	1.2	O K
7200 min Winter	35.493	0.043	0.0	0.2	0.2	0.9	O K
8640 min Winter	35.485	0.035	0.0	0.1	0.1	0.7	O K
10080 min Winter	35.481	0.031	0.0	0.1	0.1	0.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	50.836	0.0	8.0	33
60 min Winter	31.437	0.0	10.0	62
120 min Winter	18.865	0.0	12.0	120
180 min Winter	13.846	0.0	13.3	178
240 min Winter	11.071	0.0	14.2	234
360 min Winter	8.064	0.0	15.5	342
480 min Winter	6.437	0.0	16.5	398
600 min Winter	5.401	0.0	17.3	468
720 min Winter	4.678	0.0	18.0	544
960 min Winter	3.727	0.0	19.1	702
1440 min Winter	2.703	0.0	20.8	998
2160 min Winter	1.958	0.0	22.5	1428
2880 min Winter	1.557	0.0	23.8	1872
4320 min Winter	1.126	0.0	25.7	2468
5760 min Winter	0.894	0.0	27.1	3056
7200 min Winter	0.747	0.0	28.2	3680
8640 min Winter	0.645	0.0	29.1	4408
10080 min Winter	0.570	0.0	29.8	5128

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.400	Shortest Storm (mins)	15
Ratio R	0.414	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.039

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.039

Model Details

Storage is Online Cover Level (m) 37.070

Complex Structure

Filter Drain

Infiltration Coefficient Base (m/hr)	0.00000	Pipe Diameter (m)	0.150
Infiltration Coefficient Side (m/hr)	0.00000	Pipe Depth above Invert (m)	0.000
Safety Factor	2.0	Slope (1:X)	0.0
Porosity	0.30	Cap Volume Depth (m)	0.500
Invert Level (m)	35.450	Cap Infiltration Depth (m)	0.000
Trench Width (m)	1.0	Number of Pipes	1
Trench Length (m)	5.5		

Cellular Storage

Invert Level (m)	35.450	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.95
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	19.3	19.3	1.001	0.0	37.3
1.000	19.3	37.3			

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	12.0
Max Percolation (l/s)	16.7	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	36.620	Cap Volume Depth (m)	0.240

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0026-4000-1500-4000
Design Head (m)	1.500
Design Flow (l/s)	0.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	26
Invert Level (m)	35.450
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Hydro-Brake® Optimum Outflow Control

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	0.4
Flush-Flo™	0.115	0.2
Kick-Flo®	0.233	0.2
Mean Flow over Head Range	-	0.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.2	1.200	0.4	3.000	0.5	7.000	0.8
0.200	0.2	1.400	0.4	3.500	0.6	7.500	0.8
0.300	0.2	1.600	0.4	4.000	0.6	8.000	0.8
0.400	0.2	1.800	0.4	4.500	0.6	8.500	0.9
0.500	0.2	2.000	0.5	5.000	0.7	9.000	0.9
0.600	0.3	2.200	0.5	5.500	0.7	9.500	0.9
0.800	0.3	2.400	0.5	6.000	0.7		
1.000	0.3	2.600	0.5	6.500	0.8		

Summary of Results for 100 year Return Period

Half Drain Time : 507 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	35.798	0.348	0.0	0.2	0.2	7.0	O K
30 min Summer	35.903	0.453	0.0	0.2	0.2	9.1	O K
60 min Summer	36.007	0.557	0.0	0.3	0.3	11.1	O K
120 min Summer	36.097	0.647	0.0	0.3	0.3	12.7	O K
180 min Summer	36.131	0.681	0.0	0.3	0.3	13.4	O K
240 min Summer	36.142	0.692	0.0	0.3	0.3	13.6	O K
360 min Summer	36.138	0.688	0.0	0.3	0.3	13.5	O K
480 min Summer	36.126	0.676	0.0	0.3	0.3	13.2	O K
600 min Summer	36.111	0.661	0.0	0.3	0.3	13.0	O K
720 min Summer	36.097	0.647	0.0	0.3	0.3	12.7	O K
960 min Summer	36.066	0.616	0.0	0.3	0.3	12.2	O K
1440 min Summer	36.008	0.558	0.0	0.3	0.3	11.1	O K
2160 min Summer	35.932	0.482	0.0	0.2	0.2	9.7	O K
2880 min Summer	35.870	0.420	0.0	0.2	0.2	8.4	O K
4320 min Summer	35.765	0.315	0.0	0.2	0.2	6.4	O K
5760 min Summer	35.662	0.212	0.0	0.2	0.2	4.3	O K
7200 min Summer	35.584	0.134	0.0	0.2	0.2	2.7	O K
8640 min Summer	35.539	0.089	0.0	0.2	0.2	1.8	O K
10080 min Summer	35.515	0.065	0.0	0.2	0.2	1.3	O K
15 min Winter	35.842	0.392	0.0	0.2	0.2	7.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	102.063	0.0	7.1	19
30 min Summer	66.587	0.0	9.4	33
60 min Summer	41.341	0.0	11.8	64
120 min Summer	24.784	0.0	14.2	122
180 min Summer	18.127	0.0	15.6	182
240 min Summer	14.433	0.0	16.5	240
360 min Summer	10.455	0.0	18.0	348
480 min Summer	8.313	0.0	19.1	402
600 min Summer	6.953	0.0	20.0	464
720 min Summer	6.007	0.0	20.7	526
960 min Summer	4.765	0.0	21.9	664
1440 min Summer	3.433	0.0	23.6	938
2160 min Summer	2.469	0.0	25.4	1344
2880 min Summer	1.953	0.0	26.7	1756
4320 min Summer	1.401	0.0	28.7	2548
5760 min Summer	1.106	0.0	30.0	3288
7200 min Summer	0.920	0.0	31.1	3896
8640 min Summer	0.791	0.0	31.9	4576
10080 min Summer	0.697	0.0	32.7	5240
15 min Winter	102.063	0.0	8.0	19

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	35.962	0.512	0.0	0.3	0.3	10.3	O K
60 min Winter	36.086	0.636	0.0	0.3	0.3	12.5	O K
120 min Winter	36.190	0.740	0.0	0.3	0.3	14.4	O K
180 min Winter	36.233	0.783	0.0	0.3	0.3	15.2	O K
240 min Winter	36.250	0.800	0.0	0.3	0.3	15.5	O K
360 min Winter	36.254	0.804	0.0	0.3	0.3	15.6	O K
480 min Winter	36.240	0.790	0.0	0.3	0.3	15.3	O K
600 min Winter	36.221	0.771	0.0	0.3	0.3	15.0	O K
720 min Winter	36.203	0.753	0.0	0.3	0.3	14.7	O K
960 min Winter	36.164	0.714	0.0	0.3	0.3	13.9	O K
1440 min Winter	36.082	0.632	0.0	0.3	0.3	12.4	O K
2160 min Winter	35.970	0.520	0.0	0.3	0.3	10.4	O K
2880 min Winter	35.879	0.429	0.0	0.2	0.2	8.6	O K
4320 min Winter	35.727	0.277	0.0	0.2	0.2	5.6	O K
5760 min Winter	35.574	0.124	0.0	0.2	0.2	2.5	O K
7200 min Winter	35.514	0.064	0.0	0.2	0.2	1.3	O K
8640 min Winter	35.496	0.046	0.0	0.2	0.2	0.9	O K
10080 min Winter	35.489	0.039	0.0	0.2	0.2	0.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	66.587	0.0	10.6	33
60 min Winter	41.341	0.0	13.2	62
120 min Winter	24.784	0.0	15.9	120
180 min Winter	18.127	0.0	17.5	178
240 min Winter	14.433	0.0	18.6	234
360 min Winter	10.455	0.0	20.2	346
480 min Winter	8.313	0.0	21.4	448
600 min Winter	6.953	0.0	22.4	482
720 min Winter	6.007	0.0	23.2	556
960 min Winter	4.765	0.0	24.5	712
1440 min Winter	3.433	0.0	26.5	1012
2160 min Winter	2.469	0.0	28.5	1452
2880 min Winter	1.953	0.0	30.0	1876
4320 min Winter	1.401	0.0	32.2	2720
5760 min Winter	1.106	0.0	33.8	3288
7200 min Winter	0.920	0.0	35.0	3824
8640 min Winter	0.791	0.0	35.9	4416
10080 min Winter	0.697	0.0	36.8	5136

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.400	Shortest Storm (mins)	15
Ratio R	0.414	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.039

Time (mins) From:	To:	Area (ha)
0	4	0.039

Model Details

Storage is Online Cover Level (m) 37.070

Complex Structure

Cellular Storage

Invert Level (m)	35.450	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.95
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	**Area (m²)**	**Inf. Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**
0.000	19.3	19.3	1.001	0.0	37.3
1.000	19.3	37.3			

Filter Drain

Infiltration Coefficient Base (m/hr)	0.00000	Pipe Diameter (m)	0.150
Infiltration Coefficient Side (m/hr)	0.00000	Pipe Depth above Invert (m)	0.000
Safety Factor	2.0	Slope (1:X)	0.0
Porosity	0.30	Cap Volume Depth (m)	0.500
Invert Level (m)	35.450	Cap Infiltration Depth (m)	0.000
Trench Width (m)	1.0	Number of Pipes	1
Trench Length (m)	5.5		

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	12.0
Max Percolation (l/s)	16.7	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	36.620	Cap Volume Depth (m)	0.240

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0026-4000-1500-4000
Design Head (m)	1.500
Design Flow (l/s)	0.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	26
Invert Level (m)	35.450
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Hydro-Brake® Optimum Outflow Control

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	0.4
Flush-Flo™	0.115	0.2
Kick-Flo®	0.233	0.2
Mean Flow over Head Range	-	0.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.2	1.200	0.4	3.000	0.5	7.000	0.8
0.200	0.2	1.400	0.4	3.500	0.6	7.500	0.8
0.300	0.2	1.600	0.4	4.000	0.6	8.000	0.8
0.400	0.2	1.800	0.4	4.500	0.6	8.500	0.9
0.500	0.2	2.000	0.5	5.000	0.7	9.000	0.9
0.600	0.3	2.200	0.5	5.500	0.7	9.500	0.9
0.800	0.3	2.400	0.5	6.000	0.7		
1.000	0.3	2.600	0.5	6.500	0.8		

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 588 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	35.946	0.496	0.0	0.2	0.2	10.0	O K
30 min Summer	36.109	0.659	0.0	0.3	0.3	12.9	O K
60 min Summer	36.265	0.815	0.0	0.3	0.3	15.8	O K
120 min Summer	36.401	0.951	0.0	0.3	0.3	18.3	O K
180 min Summer	36.676	1.226	0.0	0.4	0.4	19.3	O K
240 min Summer	36.730	1.280	0.0	0.4	0.4	19.7	O K
360 min Summer	36.741	1.291	0.0	0.4	0.4	19.8	O K
480 min Summer	36.721	1.271	0.0	0.4	0.4	19.6	O K
600 min Summer	36.693	1.243	0.0	0.4	0.4	19.4	O K
720 min Summer	36.639	1.189	0.0	0.4	0.4	19.2	O K
960 min Summer	36.418	0.968	0.0	0.3	0.3	18.6	O K
1440 min Summer	36.347	0.897	0.0	0.3	0.3	17.3	O K
2160 min Summer	36.252	0.802	0.0	0.3	0.3	15.6	O K
2880 min Summer	36.169	0.719	0.0	0.3	0.3	14.0	O K
4320 min Summer	36.029	0.579	0.0	0.3	0.3	11.5	O K
5760 min Summer	35.918	0.468	0.0	0.2	0.2	9.4	O K
7200 min Summer	35.831	0.381	0.0	0.2	0.2	7.7	O K
8640 min Summer	35.756	0.306	0.0	0.2	0.2	6.2	O K
10080 min Summer	35.674	0.224	0.0	0.2	0.2	4.5	O K
15 min Winter	36.014	0.564	0.0	0.3	0.3	11.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	142.888	0.0	10.1	19
30 min Summer	93.222	0.0	13.3	34
60 min Summer	57.877	0.0	16.6	64
120 min Summer	34.697	0.0	20.0	122
180 min Summer	25.377	0.0	21.9	182
240 min Summer	20.206	0.0	23.3	242
360 min Summer	14.636	0.0	25.3	360
480 min Summer	11.638	0.0	26.9	414
600 min Summer	9.735	0.0	28.1	476
720 min Summer	8.410	0.0	29.1	542
960 min Summer	6.671	0.0	30.8	686
1440 min Summer	4.806	0.0	33.2	966
2160 min Summer	3.457	0.0	35.8	1380
2880 min Summer	2.734	0.0	37.7	1788
4320 min Summer	1.961	0.0	40.5	2592
5760 min Summer	1.548	0.0	42.4	3344
7200 min Summer	1.288	0.0	44.0	4112
8640 min Summer	1.108	0.0	45.3	4848
10080 min Summer	0.975	0.0	46.4	5648
15 min Winter	142.888	0.0	11.4	19

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	36.198	0.748	0.0	0.3	0.3	14.6	O K
60 min Winter	36.375	0.925	0.0	0.3	0.3	17.8	O K
120 min Winter	36.799	1.349	0.0	0.4	0.4	20.6	Flood Risk
180 min Winter	36.868	1.418	0.0	0.4	0.4	21.9	Flood Risk
240 min Winter	36.904	1.454	0.0	0.4	0.4	22.4	Flood Risk
360 min Winter	36.932	1.482	0.0	0.4	0.4	22.8	Flood Risk
480 min Winter	36.920	1.470	0.0	0.4	0.4	22.6	Flood Risk
600 min Winter	36.892	1.442	0.0	0.4	0.4	22.2	Flood Risk
720 min Winter	36.873	1.423	0.0	0.4	0.4	21.9	Flood Risk
960 min Winter	36.831	1.381	0.0	0.4	0.4	21.2	Flood Risk
1440 min Winter	36.710	1.260	0.0	0.4	0.4	19.6	O K
2160 min Winter	36.342	0.892	0.0	0.3	0.3	17.2	O K
2880 min Winter	36.223	0.773	0.0	0.3	0.3	15.0	O K
4320 min Winter	36.027	0.577	0.0	0.3	0.3	11.4	O K
5760 min Winter	35.879	0.429	0.0	0.2	0.2	8.6	O K
7200 min Winter	35.761	0.311	0.0	0.2	0.2	6.3	O K
8640 min Winter	35.613	0.163	0.0	0.2	0.2	3.3	O K
10080 min Winter	35.537	0.087	0.0	0.2	0.2	1.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	93.222	0.0	14.9	33
60 min Winter	57.877	0.0	18.6	62
120 min Winter	34.697	0.0	22.4	120
180 min Winter	25.377	0.0	24.6	178
240 min Winter	20.206	0.0	26.1	236
360 min Winter	14.636	0.0	28.4	348
480 min Winter	11.638	0.0	30.1	454
600 min Winter	9.735	0.0	31.5	506
720 min Winter	8.410	0.0	32.6	566
960 min Winter	6.671	0.0	34.5	720
1440 min Winter	4.806	0.0	37.2	1024
2160 min Winter	3.457	0.0	40.2	1488
2880 min Winter	2.734	0.0	42.3	1904
4320 min Winter	1.961	0.0	45.4	2728
5760 min Winter	1.548	0.0	47.7	3568
7200 min Winter	1.288	0.0	49.4	4392
8640 min Winter	1.108	0.0	50.9	4936
10080 min Winter	0.975	0.0	52.1	5448

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.400	Shortest Storm (mins)	15
Ratio R	0.414	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.039

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.039

Model Details

Storage is Online Cover Level (m) 37.070

Complex Structure

Filter Drain

Infiltration Coefficient Base (m/hr)	0.00000	Pipe Diameter (m)	0.150
Infiltration Coefficient Side (m/hr)	0.00000	Pipe Depth above Invert (m)	0.000
Safety Factor	2.0	Slope (1:X)	0.0
Porosity	0.30	Cap Volume Depth (m)	0.500
Invert Level (m)	35.450	Cap Infiltration Depth (m)	0.000
Trench Width (m)	1.0	Number of Pipes	1
Trench Length (m)	5.5		

Cellular Storage

Invert Level (m)	35.450	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.95
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	19.3	19.3	1.001	0.0	37.3
1.000	19.3	37.3			

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	12.0
Max Percolation (l/s)	16.7	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	36.620	Cap Volume Depth (m)	0.240

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0026-4000-1500-4000
Design Head (m)	1.500
Design Flow (l/s)	0.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	26
Invert Level (m)	35.450
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Hydro-Brake® Optimum Outflow Control

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	0.4
Flush-Flo™	0.115	0.2
Kick-Flo®	0.233	0.2
Mean Flow over Head Range	-	0.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.2	1.200	0.4	3.000	0.5	7.000	0.8
0.200	0.2	1.400	0.4	3.500	0.6	7.500	0.8
0.300	0.2	1.600	0.4	4.000	0.6	8.000	0.8
0.400	0.2	1.800	0.4	4.500	0.6	8.500	0.9
0.500	0.2	2.000	0.5	5.000	0.7	9.000	0.9
0.600	0.3	2.200	0.5	5.500	0.7	9.500	0.9
0.800	0.3	2.400	0.5	6.000	0.7		
1.000	0.3	2.600	0.5	6.500	0.8		

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DRAINAGE IMPLEMENTATION, MANAGEMENT & MAINTENANCE PLAN

40 STATION APPROACH
RUISLIP

HA4 6RZ

PREPARED FOR:	Chartsfield Limited
JOB NO:	P22-1031
DATE:	8th September 2023
ISSUE NO:	1

DOCUMENT HISTORY

Issue	Description	Date
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CONTENTS

APPENDICES

1. INTRODUCTION

1.1 This report has been prepared by Simpson TWS on behalf of Chartsfield Limited to provide details of the operation and maintenance requirements for the drainage proposals for the development.

1.2 Chartsfield will appoint an established management company who will be responsible for the management / maintenance of their estate infrastructure. The management company would ensure that the development's drainage system is operated and maintained in accordance with this plan.

1.3 On occupation of the development, this maintenance and management plan should be incorporated into the development's "Operation and Maintenance Manual" with the as-built drainage system operated and maintained in accordance with the requirements set out in the following section of this report to prevent a reduction in the performance of the drainage system over the lifetime of the development.

1.4 Chartsfield's appointed management company should ensure that the maintenance contractor tasked with carrying out any maintenance works provides a risk assessment and method statement that adopts best practice health and safety policies for maintenance personnel throughout the duration of any maintenance works. Measures may include:

- Ensure the use of safe systems of work and procedures are followed.
- Certificated operatives only to be used for all confined space entry.
- Ensure appropriate PPE is worn at all times including the use of safety goggles, ear defenders and other relevant equipment when using high pressure jetting.
- Do not work in weather conditions where flooding or surging is likely.
- Erect barriers where appropriate and provide adequate lighting.
- No operations to be carried out by operatives working alone.
- Time maintenance to not conflict with other on-site activities.
- Method statement to be prepared and approved prior to entry into confined space.

2. DRAINAGE IMPLEMENTATION PLAN

2.1 This Implementation Plan sets out measures to be implemented during construction of the surface water drainage system for the scheme to ensure the site and areas downstream are protected from runoff during construction of the development. It is recommended that the plan is incorporated into the Contractor's Construction Health and Safety Plan with the development carried out in accordance with the measures proposed.

2.2 The surface water drainage network and associated outfalls / flow controls will be constructed at an early stage of the development`s programme as part of the earthworks phase. During construction, this will assist in managing runoff and help settle out the high volumes of sediments created during construction.

2.3 The use of porous surfacing will require changes to conventional construction practices and procedures used for traditional car parking and other paved areas, which during the initial stages of the development are often used as access roads and storage areas. Together with runoff from the construction site, which can be heavily laden with silt, such activities are likely to block the porous surfacing system, therefore, the following measures would be implemented to address the issue.

- Installation of the porous surfacing would be carried out at the end of the development programme, when most construction activities are complete, thus minimising the risk of clogging.

- Should it be necessary to construct areas of porous surfacing at an early stage in the construction programme, an impermeable layer of Dense Bitumen Macadam (DBM) would be laid beneath the surfacing materials to act as a temporary road surface. When most construction activities are complete, holes would be punched through the impermeable layer with final surfacing laid.

2.4 It is not always possible to ensure that new impermeable areas are immediately connected to the drainage system. Therefore, the following additional measures will be implemented to ensure construction runoff is appropriately managed:

- Protective coverings would be used to help prevent runoff stripping material stockpiles.

- Plant and wheel washing would take place in a designated location. The area would be tanked and not allowed to discharge into the drainage system or infiltrate into the ground. Effluent should be treated as contaminated waste and disposed off site by a licensed waste management operator.

- Surfaces used as access roads and storage areas during construction should be swept regularly to prevent accumulation of dust and mud.

- There is a chance that groundwater will be encountered in excavations. Such water would not be discharged to the drainage system until the amount of suspended solids has been reduced through the controlled use of skips or tanks, which will act as stilling basins.

- To prevent contamination associated with the use of oils and hydrocarbons during construction, the Contractor would ensure that the following precautionary measures are employed during construction:

- Regular maintenance of machinery and plant.
- Use of drip trays.
- Regular checking of machinery and plant for oil leaks.
- Use of correct storage facilities.
- Regular checks for signs of wear and tear on tanks.
- Specific procedures are followed when refuelling.
- Use of a designated area for refuelling.
- Emergency spill kit to be located near refuelling area.
- Regular emptying of bunds.
- Tanks should be located in secure areas to stop vandalism.

2.5 The above measures would help to ensure that untreated construction runoff would not be discharged to the surface water drainage system.

2.6 During construction, all components of the drainage system should be constructed in accordance with relevant drawings, specifications, and manufacturer's guidelines. Further to this Building Control should visit site on a regular basis to inspect completed works and ensure that the drainage system in installed correctly.

2.7 Upon completion, all underground pipework would be jet cleaned and CCTV surveyed, areas of porous surfacing would be swept and cleaned and silt / debris present in the swales would be removed. The Contractor would be responsible for rectifying any significant defects identified at this stage and for a period of approximately 12 months thereafter. At the end of this period a further inspection will be carried out by the Contract Administrator and on completion of any outstanding remedial works, the drainage system would be handed over.

3. DRAINAGE MANAGEMENT & MAINTENANCE PLAN

3.1 This Drainage Management & Maintenance Plan provides details of the plan proposed for maintenance and management of the drainage scheme associated with the proposed development.

3.2 On occupation of the development, it is recommended that each element of the as-built drainage system is maintained in accordance with the regime set out in the tables below.

Table 1: Below Ground Drainage System - Operation and Maintenance Requirements

Maintenance schedule	Required action	Frequency
Regular maintenance	Remove all litter and debris from external hard landscaped areas and adjacent landscaping, which may pose a risk to the performance of the system.	Monthly.
	Remove build-up of sediment / silt in catch-pits and dispose of oils / petrol residues using safe standard practices.	As required.
	Stabilise and mow adjacent landscaped areas and remove weeds.	
Remedial actions	Repair or rehabilitate inlet and outlets to ensure they are in good condition and operating as designed.	
	Remediate any landscaping, which has raised to within 50mm of the level of adjacent hard landscaping.	
Monitoring	Check of all inlets / outlets for blockages or evidence of physical damage with any necessary remedial action or clearance carried out if required.	On a monthly basis for the first 3 months of operation, thereafter every 6 months & following severe rainfall events.
	Inspect all surfaces for ponding, or silt accumulation. Record areas where water is ponding for more than 48 hours and carry out any remedial work deemed necessary.	After severe storms.

Table 2: Permeable Paving - Operation and Maintenance Requirements

Maintenance schedule	Required action	Frequency
Regular maintenance	Remove all litter and debris from drained surfaces areas and adjacent hard / soft landscaping, which may pose a risk to the performance of the system.	Monthly.
	Sweep permeable paved areas. If necessary, use jet wash or suction sweeper. Any jointing aggregate lost from the joints must be replaced as necessary with 2/6.3mm single sized aggregate, brushed into joints.	Three times a year at end of winter, mid-summer, after autumn leaf fall, or as required based on site-specific observations of clogging.
	Stabilise and mow adjacent landscaped areas and remove weeds.	As required.
Remedial actions	Remediate any landscaping, which has raised to within 50mm of the level of adjacent hard landscaping.	
	Carry out remedial work to any depressions, rutting and cracked or broken paving blocks within the permeable paved areas that are considered detrimental to the structural performance or a hazard to users.	
	Carry out repair / rehabilitation works to inlets, outlets, overflows and vents.	
Monitoring	Inspect silt accumulation rates within the permeable paved areas and establish appropriate brushing frequencies.	Annually.
	Check of all inlets, outlets, overflows and vents for blockages or evidence of physical damage with any necessary remedial action or clearance carried out if required.	On a monthly basis for the first 3 months of operation, thereafter every 6 months & following severe rainfall events.
	Inspect and identify any areas that are not operating correctly	On a monthly basis for the first 3 months of operation, thereafter every 6 months & following severe rainfall events.

Table 3: Flow Control Chamber - Operation and Maintenance Requirements

Maintenance schedule	Required action	Frequency
Regular maintenance	Cleaning off the flow control devices of any debris/ sediment.	As required
Remedial Actions	Flow control device repairs.	As required
	Repair of erosion damage, or damage to chamber.	
Monitoring	Inspection of the chamber for debris and sediment build up.	Monthly for first 3 months, thereafter, every 6 months and following severe storm events.

Table 4: Geocellular Storage Tank - Operation and Maintenance Requirements

Maintenance schedule	Required action	Frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for first 3 months of operation, then every 6 months.
	Debris removal from catchment surface (where may cause risks to performance).	Monthly.
	Where rainfall infiltrates into blocks from above, check surface of filter for blockage by silt, algae or other matter. Remove and replace surface infiltration medium as necessary.	Monthly / after severe storms.
	Remove sediment from pre-treatment structures.	Annually, or as required.
Remedial actions	Repair/rehabilitation of inlets, outlet, overflows and vents.	As required.
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed.	Annually and after large storms.

APPENDIX A

PERMEABLE PAVING OPERATION & MAINTENANCE MANUAL

MARSHALLS LANDSCAPE PRODUCTS

TECHNICAL ADVISORY SERVICES DEPARTMENT

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GUIDELINES FOR THE MAINTENANCE OF MARSHALLS PRIORA CONCRETE BLOCK PAVING

These notes are intended for general guidance and are not intended to be exhaustive.

Marshalls manufacture a range of paving materials in clay, concrete and natural stone which provide a durable, hardwearing surface. All surfacing materials may, during service, experience some degree of surface staining and therefore require regular maintenance and good cleaning practice to maintain the overall appearance of the paving.

MAINTENANCE

To ensure the performance of the Priora permeable paving, Marshalls recommend that there is a maintenance regime undertaken.

The maintenance of the pavement is to ensure the infiltration of the paving is not compromised. The following guidelines are offered as an initial regime, but maybe either increased or decreased depending on paving's local environment and any external contributing factors.

- A visual inspection of the paving should be carried out on a regular basis, ensuring that the joints are kept fully filled. This will confirm the effectiveness of the agitation maintenance due to variations between sites and allow any refinement of the regular agitation activity if necessary.

- The paving should be agitated (e.g. brushed, vacuumed, etc.) at least twice a year. This is to ensure no vegetation of any sort is allowed to grow and develop in the joints. Ideally, this activity should be carried out in the spring and autumn seasons.

- The paving should be inspected after any heavy precipitation to ensure no displacement of any organic matter onto the surface of the pavement.

- For winter maintenance, the controlled use of de-icing products may be used without causing significant detrimental effects towards the permeable pavements performance. When used carefully, the use of these chlorides will not result in an increase in the chloride levels in the local ground.

- Where non-infiltration systems have been employed, the inspection of the outfalls should be undertaken initially on a twice-yearly basis.

- Weed growth – when sedimentation occurs in areas of permeable paving then there is the potential for weed growth, this will typically occur where there are overhanging trees or soft landscaping slopes down on to the paving or in areas which do not receive over run from vehicles particularly frequently.

- Weeds can be removed from the surface through the application of weed killers containing Glyphosate. Glyphosate based weed killers are the most common for general-purpose use, they are most effective on grasses and perennial weeds with non-woody stems. Weeds should be sprayed when they are actively growing so that the Glyphosate will go down to the root and kill the weed completely. Glyphosate will be neutralized upon contact with the ground, which makes it safe to plant in the area soon after treatment. It is available ready mixed or as a concentrate. With the ready mix you will paying a lot for the water that it is diluted with, but if you only have a small plot or if you don't have a safe chemical storage cupboard, then ready mix is the best option.

- Glyphosate based weed killers include: ***Roundup, Tumbleweed*** **and** ***B&Q complete*****.**

Depending on the amount of usage and the environment the permeable pavement has received and been exposed to, the laying course material may require either cleaning after a 25 to 30 year period. This would be evident if the infiltration rate of the paving became prolonged, allowing ponding to develop. Should this occur, the uplifting and cleaning (or replacing) of the laying course maybe considered. The laying course material, jointing and Priora blocks may be reused, minimising costs.

Marshalls would advise during the design stage of the project, consideration should be given to the placement and location of underground utilities. This is intended to minimise the need to carry out any excavation work within the main permeable pavement construction

Should a situation arise where access is required, Marshalls would suggest the following approach to the works.

- The initial trench width for excavating should be related to the depth of the sub-base material. For example, consideration to the width of the utility should be considered, plus a degree of working space. The utility undertaker will decide this. In addition to this figure, Marshalls would advise the overall width is determined by the depth of the open graded material plus 20%.

- When removing the first block, a suitable location, such as at the perimeter of the installation or where a unit exists with a larger joint width surrounding it should be considered. Next, as much jointing material should be cleared as possible to reduce the integrity being offered by this material.

- Once a block has become suitably loosened, a block lifter should used to remove it. Due to the interlock offered by the spacer nib profile, it may be necessary to have the block being lifted held in a lifted position, whilst a second person taps the adjacent blocks with a suitable lump hammer or rubber mallet. This may be repeated for the first few units during removal.

- Once the desired area of paving has been removed and carefully staked for reuse, a suitable surfacing material (e.g. membrane, wooden boards, etc.) should be placed on the surrounding paving for the laying course and sub-base materials to be separately stock-piled.

- Once completion of the utility work, the pavement should be reconstructed in accordance with the Marshalls Installation Guide.

- If the pavement construction contains any water-proof membranes or geotextiles, these should be sliced, folded back and weighed down during the opening of the pavement.

- Upon reinstatement, these should be folded back into their original position and be overlaid with a new corresponding material (overlap dimension to be determined between the utility contractor and the membrane/geotextile manufacturer; consideration to bonding/welding the reinstated material should be given depending on site conditions) which has been cut to an appropriate size, before continuing with the next layer of construction.

APPENDIX B

FLOW CONTROL CHAMBER OPERATION & MAINTENANCE MANUAL

HYDRO-BRAKE® FLOW CONTROL

MAINTENANCE AND SAFETY DATA SHEET

MAINTENANCE

Normally, little maintenance is required as there are no moving parts within the Hydro-Brake® Flow Control. Experience has shown that if blockages occur they do so at the intake, and the cause on such occasions has been due to a lack of attention to engineering detail such as approach velocities being too low, inadequate benching, or the use of units below the minimum recommended size. Hydro-Brake® Flow Controls are fitted with a pivoting by-pass door, which allows the manhole chamber to be drained down should blockages occur. The smaller type conical units, below the minimum recommended size, are also supplied with roding facilities or vortex suppressor pipes as standard.

Following installation of the Hydro-Brake® Flow Control it is vitally important that any extraneous material i.e. Building materials are removed from the unit and the chamber. After the system is made live, and assuming that the chamber design is satisfactory, it is recommended that each unit be inspected monthly for three months and thereafter at six monthly intervals with hose down if required. If problems are experienced please do not hesitate to contact the company so that an investigation may be made.

Hydro-Brake® Flow Controls are typically manufactured from grade 304 Stainless Steel which has an estimated life span in excess of the design life of drainage systems.

COSHH

Hydro-Brake® Flow Controls are manufactured from Stainless Steel, which is not regarded as hazardous to health and exhibits no chemical hazard when used under normal circumstances for the stated applications.

MANUAL HANDLING

The handling of Hydro-Brake® Flow Controls should be in accordance with current legislation and regulations:

- The Health and Safety at Work Act 1972.
- The Management of Health and Safety at Work Regulations 1992.
- The Manual Handling Operations Regulations 1992.

All published and printed by the Health and Safety Executive.

APPENDIX C

GEOCELLULAR STORAGE TANK OPERATION & MAINTENANCE MANUAL

GEOLIGHT maintenance

Once received stormwater reaches the storage reservoir through one or more distribution pipes laid out on the side faces of the Geolight blocks.

These distribution pipes are covered in a trench filled with draining material requiring little compaction, like washed rolled pebbles, free from fines, and 15/25 grading.

A 10 mm mesh geogrid or GEOtextile, laid between the distribution pipe and Geolight, prevents the horizontal Geolight blocks being clogged by the draining materials.

The permeability of the supply and distribution pipe located on the periphery of the reservoir is designed to prevent any clogging of the system upstream of the stormwater drain.
This sizing is checked for each supply. It is obtained thanks to design programmes by SDS limited following testing of a size 1 reservoir in which all hydraulic configurations were studied.

These tests also made it possible to check the very good vertical and horizontal permeabilities of Geolight blocks and this general layout is usually accepted.

The choice of one of these layouts or a combination of them is according to:
- the place reserved for the reservoir
- available slopes
- hydraulic parameters (discharge)
- position of stormwater input and output systems.

The ends of feeder drains (distribution pipes) are connected to inspection chambers(manholes), acting as settling tanks and making inspection and maintenance of the whole distribution pipe possible. *The silts and sediments contained within the surface water network will remain within the distribution pipe which can be accessed for ongoing maintenance in line with the contract requirements. This means that this sediment cannot enter the crate structure of the attenuation tanks which will not require any maintenance.*

For small discharges, stormwater does not penetrate Geolight blocks, but circulates either in an appropriate bypass, or in the distribution pipe drain. This is for draining the first water which will be handled downstream if required.

When the reservoir is drained, water is drained through a distribution pipe possibly the same as the one located at the input which operates in the opposite direction. Drainage discharge is controlled by the downstream system piping.

A ventilation system consisting of a drainage geocomposite is fresh air vented in the inspection pits. It is laid out in the upper part of the distribution pipes and the general space occupied by the reservoir.

We generally recommend that the stormwater tank inspection chambers are checked periodically in conjunction with general maintenance of the underground pipe network.